Themis SPARC 10MP Software Manual

Version 2.0 — March 20, 1996

Themis Computer—Americas and Pacific Rim
3185 Laurelview Court
Fremont, CA 94538
Phone (510) 252-0870
Fax (510) 490-5529
Web Site: *www.themix.com*

Themis Computer—Rest of World
1, Rue Des Essarts
Z.A. De Mayencin
38610 Gieres, France
Phone 33 76 59 60 61
Fax 33 76 63 00 30

Table of Contents

How to Use This Manual 1

The Themis Computer SPARC 10MP is a SPARC-based single-board VMEbus computer. The software interface for the SPARC 10MP is transparently implemented under Solaris 1.x and Solaris 2.x and is compatible with Sun's SPARCstation 10 workstation. Themis Computer has also developed custom software that enables software programmers to effectively use the powerful features of the SPARC 10MP.

1.1 Intended Audience

The custom software containing programs, documentation and packaging, is targeted for different kinds of software users:

- System Administrators who install the software and perform the necessary software configuration.
- Users who perform day-to-day operations on SPARC 10MP systems.
- Application programmers who write user-level programs that utilize the VMEbus interface provided under Solaris.
- System programmers / device driver writers who develop kernel-level device drivers for VMEbus devices.

Some of these functions overlap one another. The basic concepts required for many of these functions are common. This manual is structured around the basic concepts of using a VMEbus system.

1.2 Organization

This document is oranized in chapters that focus on a specific functional use of the VMEbus software interface.

- Chapter 1, **How to Use This Manual**: contains a brief overview of this document and its organization.
- Chapter 2, **Installing the SPARC 10MP Software**: contains instructions on installing the many parts of the software interface on a Solaris system.
- Chapter 3, **Using the VME Interface**: is intended for users of SPARC 10MP systems. It provides instructions on using the various user level programs provided by Themis Computer. These programs could be used to test the various features of the VME interface. The programs themselves are provided along with the source code and can be modified by the users of the system. The programs can be found in the 'example' subdirectory.
- Chapter 4, **Writing Programs for the VMEbus**: is intended for programmers who are not familiar with the Solaris architecture and the concepts of the VMEbus. The document discusses the features of Solaris drivers and VMEbus devices as they pertain to the Themis SPARC 10MP product and provides tips on writing programs to utilize the different features of the VMEbus.
- Chapter 5, **WritingVME Device Drivers**: is intended for systems programmers writing device drivers for VMEbus devices. The guide provides basic information on VMEbus specific features that influence the design of drivers for VMEbus devices. The guide also contains tips on programming VMEbus devices without writing custom device drivers.
- Chapter 6, **Programmers Manual**: contains extensive information useful to experienced programmers who would use the SPARC 10MP under Solaris Operating Environment.
- Chapter 7, **Advanced Configuration of SPARC 10MP**: the SPARC 10MP product provides powerful advanced features like generating a SYSRESET on the VMEbus, configuring the interrupt mechanism etc. Themis Computer periodically issues Technical Notes that detail these interfaces and ways to access them. These Technical Notes have been put together in this document.

- Chapter 8, **Sample Device Drivers**: these drivers have been written to illustrate features particular to VMEbus device drivers. These drivers are provided along with the source code. The manual pages for the drivers contain sample programs that use the drivers.
- Appendix A, **Manual Pages**: online manual pages have been added for all drivers provided by Themis Computer. Manual pages are available for the standard nexus and DMA drivers as well as the sample drivers.

1.3 *In Case Of Difficulties*

If the 10MP does not behave as described or if you encounter difficulties installing or configuring the 10MP either standalone or as part of your VMEbus system environment, please call Themis Computer technical support at 510-252-0870, fax your questions to 510-490-5529, or e-mail them to *support@themis.com*. You can also contact us at our web site: *www.themis.com*.

Installing the SPARC 10MP Software 2

The software interface for SPARC 10MP is distributed as a software package for Solaris 2.x systems. The software package is named THEMISvme and can be installed and removed like other standard Solaris software packages, by using the pkgadd and pkgrm commands.

2.1 *Installing THEMISvme*

The THEMISvme package is distributed on standard media and can be installed directly from the media. To install the package, place the installation media in the appropriate slot and execute this command:

```
# pkgadd -d <media name>
```

where `<media name>` is the name of the media on your system.

The pkgadd command will copy the contents of the package to the appropriate directories and perform the necessary installation. After the command completes, the system has to be rebooted for the new software to be operational.

The THEMISvme package can be installed safely on a system that already has a previous version of SPARC 10MP drivers installed. The previous versions of the drivers will be saved; the saved files will be restored when the THEMISvme package is removed.

The sample drivers contained in the package will be copied to the directory /opt/THEMISvme/drv. The user may choose to install these drivers by executing a script provided for that purpose. The sample drivers are not required for the normal operation of the SPARC 10MP system.

2.2 *Detailed Installation*

During the course of installation, pkgadd will prompt the user for input on optional configuration. The first prompt will request the user to choose the packages to be installed:

```
The following packages are available:
1   THEMISvme   Themis SPARC10MP VME Drivers
                (sparc) 10MP 2.0


Select package(s) you wish to process (or 'all' to process
all packages). (default: all) [?,??,q]:
```

Simply press <RETURN> to choose the THEMISvme package for installation.

The next input concerns the directory where the VME drivers will be placed:

```
Themis SPARC10MP VME Drivers
(sparc) 10MP 2.0
Themis Computer


Where should the driver objects be installed [/kernel/drv]
[?,q]
```

It is recommended that you choose the default input, /kernel/drv. If you choose to install the drivers in a directory other than /kernel/drv or /usr/kernel/drv, you may have to edit the /etc/system file to inform the kernel of the search path for driver object files.

The next prompt from pkgadd is:

The next prompt from pkgadd is:

```
This package contains scripts which will be executed with
super-user permission during the process of installing
this package.

Do you want to continue with the installation of this
package [y,n,?]
```

The THEMISvme package contains custom scripts for easy installation of the package with minimal intervention from the user. These scripts need to be executed with super-user permission. Enter y to continue with the installation of the package.

After these prompts, pkgadd will proceed with copying the files to the system and installing the necessary drivers. At the end, you should see this message:

```
Installation of <THEMISvme> was successful.
```

If for any reason, the installation is not successful, please note down the error messages on the screen and contact Themis Technical Support.

2.3 *Removing THEMISvme*

If you want to remove the software interface of SPARC10MP for any reason, you can execute the pkgrm command to remove the THEMISvme package:

```
# pkgrm THEMISvme
```

pkgrm will remove all the files contained in the package. The original contents of VME drivers before the package was installed will be restored.

2.4 *Installing THEMISvme On Diskless or Dataless Clients*

Currently, most of the software interface contained in THEMISvme can be installed on diskless and dataless client systems. On these clients, the VMEbus drivers will be copied and installed correctly. The header files and manual pages will be placed in the /opt/THEMISvme directory.

2.5 *Installing the Sample Drivers*

The /opt/THEMISvme/drv directory contains the source and binary versions of the sample device drivers in subdirectories 'src' and 'bin'. The subdirectory 'themis' includes header files that need to be copied to the /usr/include/themis directory on the system. The example programs rely on these header files.

To compile the drivers, you need to go into the subdirectory 'src' and type 'make'. The compiled driver binaries will be placed in the 'bin' subdirectory.

To install the drivers, all the files in the 'bin' directory need to be placed in a directory that usually contains driver modules. (Typically this may be /kernel/drv or /usr/kernel/drv.) Then the drivers can be installed on the system by using the add_drv command.

Before using the drivers, you need to create files under the /dev directory. These files are symbolically linked to the actual device files under the /devices directory tree.

Scripts have been provided to perform the above tasks. The install.sample scripts copies the drivers (as they are packaged) to the /kernel/drv directory. It then installs the drivers on the system, creates the files under /dev and copies the header files into the /usr/include/themis directory. The remove.sample script undoes all the installation done by the install script. You are strongly urged to carefully review the scripts before executing them.

If you need to make any changes to the drivers, you need to compile the drivers after the changes. After that you can copy the newly built driver object files to the /kernel/drv directory. You can install the new drivers on the running system by first executing the rem_drv command and then the add_drv command.

The remove.sample script removes the sample drivers from the running system. The script deconfgures the drivers from the kernel and remove the driver object files from the /kernel/drv directory.

2.6 *Sample Installation of THEMISvme*

The contents of the screen during an installation of the THEMISvme package are given below. Input by the user appears in italics.

```
# pkgadd -d /dev/rmt/0

The following packages are available:
   1   THEMISvme  Themis SPARC10MP VME Drivers
                  (sparc) 10MP 2.0


Select package(s) you wish to process (or 'all' to process
all packages). (default: all) [?,??,q]: all

Processing package instance <THEMISvme> from /dev/rmt/0


Themis SPARC10MP VME Drivers
(sparc) 10MP 2.0
Themis Computer

Where should the driver objects be installed [/kernel/drv]
[?,q] /kernel/drv
## Processing package information.
## Processing system information.
   12 package pathnames are already properly installed.
## Verifying disk space requirements.
## Checking for conflicts with packages already installed.

The following files are already installed on the system
and are being used by another package:
     /kernel/drv/vme
     /kernel/drv/vmemem

Do you want to install these conflicting files [y,n,?,q] y
```

```
This package contains scripts which will be executed with
super-user permission during the process of installing
this package.

Do you want to continue with the installation of this
package [y,n,?] y

Installing Themis SPARC10MP VME Drivers as THEMISvme


## Executing preinstall script.
Saving current files ...
[ verifying class <none> ]
## Installing part 1 of 1.
[ verifying class <devlink> ]
/kernel/drv/vme
/kernel/drv/vmedma
/kernel/drv/vmedma.conf
/kernel/drv/vmemem
[ verifying class <drv> ]
[ verifying class <include> ]
[ verifying class <manpage> ]
## Executing postinstall script.
Adding following devices to //etc/name_to_major
vmemem 67
Adding following devices to //etc/name_to_major
vmedma 95
Adding following permissions to //etc/minor_perm
vmemem:* 0666 bin bin
vmedma:* 0666 root sys

It will be necessary to do a reconfiguration reboot after
driver installation. As soon as possible, execute 'reboot
-- -r' to reboot. The new vme drivers will not be
functional till a reboot is done.

Installation of THEMISvme was successful.

The following packages are available:
  1   THEMISvmeThemis SPARC10MP VME Drivers
                (sparc) 10MP 2.0
```

```
Select package(s) you wish to process (or 'all' to process
all packages). (default: all) [?,??,q]: q
```

2.7 *Sample Installation of the Sample Drivers*

The screen output when the install.sample script is run on a system is included below. (Characters typed by the user appear in italics.)

```
# cd /opt/THEMISvme/drv
# ./install.sample

This script installs the sample device drivers for Solaris
2.4 to use the VMEbus interface on the Themis LXE+/564.

The script creates symbolic links under /dev for the
device special files.

If you want to proceed, type y or Y. Otherwise, press any
other key to abort.

y

... Replacing vmeintr interrupt driver

... Replacing vmedvma DVMA driver

Installing new drivers

Creating new devices

Copying header files

Installation completed.
```

```
+-----------------------------+
|                             |
|      Installation Script for|
|      Themis SPARC 10MP Solaris 2.4
|      sample device drivers  |
|      Version 1.2            |
|                             |
+-----------------------------+
```

Using the VME Interface 3

On Themis systems, the power supply to the board is drawn through the VME chassis. If you are able to power the board up and run diagnostics, it is very likely that the basic VMEbus interface is functioning as intended. To verify the full functionality of the VMEbus interface and to illustrate the use of the sample device drivers, Themis provides a number of test programs. These are provided along with the source code.

This document gives a brief introduction to the different test programs provided by Themis Computer. Most of the test programs have a similar user interface. The reader may like to read the tutorial on the software interface provided by Themis to gain a fuller understanding of the concepts behind the test programs.

All the example programs (with the exception of the sample DMA program) work the same way on Solaris 1.x and Solaris 2.x systems.

3.1 *Read/Write Test*

This test performs simple read/write operations on VMEbus address space.The test requires the presence of memory space accessible over the VMEbus. Usually this space is provided by a memory card or through slave access to another VME board. Invoking the test program provides you with a command shell; from this shell you can execute any of the different tests.

A test session using the read/write test is given below. User input appears within angled brackets. The test system had a memory board on the VMEbus. The memory board was installed as an A32D32 board, with address range from 0x72a00000 to 0x749fffff.

```
# <./vme_rw>

Themis Computer - VME read/write test  program

Enter command, h for help : <h>
d adrs[,length]   - display memory
h                 - print this list
m adrs[,value]    - modify memory
q                 - quit program
z adrs[,length]   - zero memory
s mode            - set VME access mode
                  0x01 = A32D32, 0x02 = A32D16
                  0x11 = A24D32, 0x12 = A24D16
                  0x21 = A16D32, 0x22 = A16D16
```

```
Enter command, h for help : <s 1>
VME file /dev/vme32d32 successfully opened.

Enter command, h for help : <z 0x72a00000 0x1000>
Done.


Enter command, h for help : <d 0x72a00000 0x20>


0x72a00000: 00000000 00000000 00000000 00000000
0x72a00010: 00000000 00000000 00000000 00000000

Enter command, h for help : <m 0x72a00000 0x20>
0x72a00000: 00000000     ? <0>
0x72a00004: 00000000     ? <1>
0x72a00008: 00000000     ? <2>
0x72a0000c: 00000000     ? <3>
0x72a00010: 00000000     ? <4>
0x72a00014: 00000000     ? <5>
0x72a00018: 00000000     ? <6>
0x72a0001c: 00000000     ? <.>


Enter command, h for help : <d 0x72a00000 0x20>
0x72a00000: 00000000 00000001 00000002 00000003
0x72a00010: 00000004 00000005 00000006 00000000


Enter command, h for help : <d 0x72a00020 0x20>
0x72a00020: 00000000 00000000 00000000 00000000
0x72a00030: 00000000 00000000 00000000 00000000
```

```
Enter command, h for help : <d 0x74a00000 0x10>

0x74a00000:
Bus Error: received signal :10


Enter command, h for help : <d 0x73a00000 0x10>

0x73a00000: 00000000 00000000 00000000 00000000

Enter command, h for help : <q>
```

3.2 *mmap Test*

This test maps a chunk of VMEbus address space into user memory and performs a read or write operation on it. The test is very similar to the read/write test. However, instead of using read() and write() system calls, the test maps the specified region into user memory using mmap(). This space can then be accessed like any other space in user memory.

The test require the presence of memory space accessible over the VMEbus. Usually this space is provided by a memory card or through slave access to another VME board. Invoking the test program provides you with a command shell; from this shell you can execute any of the different tests.

A test session using the mmap test is given below. User input appears within angled brackets. The test system had a memory board on the VMEbus. The memory board was installed as an A32D32 board, with address range from 0x60000000 to 0x61ffffff.

```
# <./vme_mmap>

Themis Computer - VME mmap test  program

Enter command, h for help : <h>
d adrs[,length]   - display memory
h                 - print this list
m adrs[,value]    - modify memory
q                 - quit program
z adrs[,length]   - zero memory
s mode            - set VME access mode
                    0x01 = A32D32, 0x02 = A32D16
                    0x11 = A24D32, 0x12 = A24D16
                    0x21 = A16D32, 0x22 = A16D16

Enter command, h for help : <s 1>
VME file /dev/vme32d32 successfully opened.

Enter command, h for help : <z 0x60000000 0x1000>
Done.


Enter command, h for help : <d 0x60000000 0x20>

0x60000000: 00000000 00000000 00000000 00000000
0x60000010: 00000000 00000000 00000000 00000000


Enter command, h for help : <m 0x60000000 0x20>


0x60000000: 00000000     ? <0>
0x60000004: 00000000     ? <1>
0x60000008: 00000000     ? <2>
0x6000000c: 00000000     ? <3>
0x60000010: 00000000     ? <4>
0x60000014: 00000000     ? <5>
0x60000018: 00000000     ? <6>
0x6000001c: 00000000     ? <.>
```

```
Enter command, h for help : <d 0x60000000 0x20>

0x60000000: 00000000 00000001 00000002 00000003
0x60000010: 00000004 00000005 00000006 00000000


Enter command, h for help : <d 0x60000020 0x20>

0x60000020: 00000000 00000000 00000000 00000000
0x60000030: 00000000 00000000 00000000 00000000


Enter command, h for help : <d 0x62000000 0x10>

0x62000000:
Bus Error: received signal :10


Enter command, h for help : <d 0x61000000 0x10>

0x61000000: 00000000 00000000 00000000 00000000


Enter command, h for help : <q>
```

3.3 *DVMA (slave mode access) test*

Memory on the SPARC10MP board can be accessed from another board on the VMEbus chassis. This type of access is called slave mode access. Slave mode access under Solaris is tied to the concept of Direct Virtual Memory Access (DVMA). DVMA is a facility present on SPARC hardware that allows a device driver to specify virtual addresses rather than physical addresses for a DMA operation. The kernel maintains a map that specifies the correspondence between the DVMA address and the physical memory.

This section describes the many features of the software interface provided by Themis Computer. The features provide the system programmer with powerful ways of accessing the VMEbus from the Solaris Operating System environment. Themis Computer has developed many sample programs that illustrate the ways of using the software interface provided by Themis. These programs are available with the source code. These programs can be used to test the configuration of a VME system; they can also be used as example programs for the use of the different features provided by the software interface.

The following subsections introduce the concepts of accessing the VMEbus from user programs. Each concept is fully illustrated by a sample program. The reader is strongly encouraged to review the sample programs while reading this guide. The programs can be freely modified in any way that the user wants to. For more information on running the sample programs, please consult the document named 'Using the VME interface'. The reader may note that though the examples in this section use VMEbus memory boards, the usage can be extended to any type of VMEbus board.

The DVMA test allocates a DVMA region in memory and performs read/write operations on the region. The user interface of this test is quite similar to that of the mmap test except that instead of physical addresses, offsets into the DVMA region are used.

It is quite illustrative to use another system to perform slave mode access to the DVMA region. Usually the DVMA test is run on one machine; on another machine on the same VMEbus chassis, the mmap test is run. Both tests can then access the same region in memory.

In the following example, 'slave' is the system that allocates a DVMA region; 'master' is the system that performs a slave mode access to the region. The slave-base-address of the slave system is assumed to be 0x0; the master's slave-base-address needs to be such that the slave address regions of the two machines don't overlap. In this case the master's slave base address is 0xa00000.

On slave:

```
# <./vme_dvma>

Themis Computer - VME DVMA test program

Enter command, h for help : <h>


d offset[,length] - display memory
h                 - print this list
m offset[,value]  - modify memory
q                 - quit program
z offset[,length] - zero memory
s size            - set up DVMA region
f                 - free DVMA region


Enter command, h for help : <s 0x2000>
id= 0x0, addr= 0x2ac8, sz= 0x2000


(The addr is used to access this region from another
machine)
Enter command, h for help : <d 0 0x20>


0x00000000: 9207bffc 4000779b f027bffc 81c7e008
0x00000010: 91e80008 9de3bfa0 b4100019 92100018


On master:

# <./vme_mmap>

Themis Computer - VME test program


Enter command, h for help : <s 0x11>
VME file /dev/vme24d32 successfully opened.
```

```
Enter command, h for help : <d 0x2ac8 0x20>

0x00002ac8: 9207bffc 4000779b f027bffc 81c7e008
0x00002ad8: 91e80008 9de3bfa0 b4100019 92100018

(Note that the contents of the region are the same when
viewed
from different machines.)

Enter command, h for help : <z 0x2ac8 0x20>
Done.


Enter command, h for help : <d 0x2ac8 0x20>

0x00002ac8: 00000000 00000000 00000000 00000000
0x00002ad8: 00000000 00000000 00000000 00000000


Now on slave:


Enter command, h for help : <d 0 0x20>

0x00000000: 00000000 00000000 00000000 00000000
0x00000010: 00000000 00000000 00000000 00000000
```

(Again, we can see that the two systems share the same view of the contents of the region. Now we will modify the contents starting from offset 0x20.)

```
Enter command, h for help : <m 0x20>

0x00000020:  0002e884     ? <1>
0x00000024:  0002e88c     ? <2>
0x00000028:  0002e898     ? <3>
0x0000002c:  0002e8a0     ? <4>
0x00000030:  0002e8a8     ? <5>
0x00000034:  0002e8b4     ? <6>
0x00000038:  0002e8c4     ? <7>
0x0000003c:  0002ea58     ? <8>
0x00000040:  0002ea5c     ? <9>
0x00000044:  0002ea68     ? <10>
0x00000048:  0002ea78     ? <11>
0x0000004c:  0002ea84     ? <.>


On master:


Enter command, h for help : <d 0x2ae8 0x30>

0x00002ae8:  00000001 00000002 00000003 00000004
0x00002af8:  00000005 00000006 00000007 00000008
0x00002b08:  00000009 00000010 00000011 0002ea84
```

(We can see that the master can view the modified contents.)

dvmatest allocates a small Direct Virtual Memory Access Region on the VMEBus address space and then writes the alphabetical characters into it. vdma is a general purpose program that allocates and frees DVMA regions. This test uses the vmedvma driver to set up a Direct Virtual Memory Access Region on the VMEBus address space. This memory can then be accessed either from the same machine or from another machine on the VME system.

simulmaster and simulslave are programs that illustrate the simultaneous access from multiple systems of a DVMA region allocated on one system. simulslave is run first; it allocates a DVMA region of 10 pages and outputs the region's size and virtual address. These are given as input to the simulmaster program on another system. The two programs try to access the same VMEBus address in alternating fashion. Suspending one of the programs will lead the other to stop; resuming the suspended program will make the other program start again.

3.4 *Interrupts Test*

This test requires the presence of two processor boards on the VME chassis. One of the boards is designated as the 'test initiator' and the other as the 'test executor.' Typically, a program on the 'test executor' machine registers to process a particular interrupt. A program on test initiator machine is used to generate an interrupt on the VMEBus; this interrupt will be received by the test executor machine. The vmeintr driver should be installed on both the machines. The interrupts that can be received are specified by the configuration file for the vmeintr driver. (usually /kernel/drv/vmeintr.conf)

Output from a test session is included below. In this case, the following interrupts were configured in the vmeintr.conf file: vector 0x80, priority 2 and vector 0x81, priority 3.

On test executor:

```
# <./vme_intr>

Themis Computer - VME interrupts test program

Enter command, h for help : <h>
e vector priority- enable an interrupt
s vector priority- send  an interrupt
w                - wait for an interrupt
d                - disable (mask) an interrupt
h                - print this list
q                - quit program

Enter command, h for help : <e 0x80 2>
Set up to receive interrupt, vector : 0x80, priority: 2


Enter command, h for help : <w>
Waiting for interrupt. You have 30 seconds to generate it.

No interrupt received in the last 30 seconds

Enter command, h for help :
```

(The wait timed out after 30 seconds because no interrupt was generated.)

On test initiator:

```
# <./vme_intr>

Themis Computer - VME interrupts test program

Enter command, h for help : <s 0x80 2>

Enter command, h for help :
```

Now on test executor:

```
Enter command, h for help : <w>
Waiting for interrupt. You have 30 seconds to generate it.

Received interrupt; vector : 0x80, priority: 2

Enter command, h for help :
```

(You may see that the wait returns immediately because an interrupt was already pending.)

```
Enter command, h for help : <e 0x81 3>
An interrupt is enabled already. Disable it first.


Enter command, h for help : <d>

Enter command, h for help : <e 0x81 3>

Set up to receive interrupt, vector : 0x81, priority: 3

Enter command, h for help : <q>
```

The roles of the test initiator and the test executor can be reversed at any time.

3.5 *DMA Test*

Direct Memory Access is the process by which a device takes control of the bus and performs data transfers to (and from) main memory or other devices. The device does this work without the help of the CPU. DMA transfers occur at significantly higher speeds as compared to normal transfers using read()/write() or mmap().

On Themis SPRAC10MP platforms, DMA access to the VMEbus is provided by the Fujitsu MBus to VMEbus Contolled. The vmedma driver provides user access to the DMA features of the MVIC controller. Using the ioctl interface provided by the driver, the user program can utilise the DMA engine and achieve high rates of data transfer.

Typically a DMA transfer occurs between memory and the VMEbus. The memory location is specified by a user virtual address that is usually obtained via malloc() or mmap(). The VMEbus location is specified by a physical VMEbus address. The VMEbus address space does not have to be mapped into user memory.

In addition to transfers between VMEbus and memory, the vmedma driver also supports transfers from memory to memory and VMEbus to VMEbus. Depending on the capabilities of the hardware platform, these transfers may be emulated in software.

The dmatest program provides a way to test the DMA mechanism on the SPARC10MP product. To illustrate the high efficiency of DMA transfers, this program is controlled by command line arguments, unlike the other test programs which provide a command shell.

The usage of the program is:

dmatest [-hold] [-release] [-source <addr>] [-dest <addr>] [-size <count>]

[-loops <loop_count>] [-blt] [-retain]

[-noblock] [-check] [-first] [-help]

By default, the program performs a transfer from memory to memory, unless the -source and/or -dest options are specified.
When -source or -dest is used, <addr> is a VMEbus address specifier as follows:

[a{64,32,24}][d{64,32,16}:][<addrhi>.]<addrlo>

<addrhi> is only required when a64 addresses are used.

To test VME to memory transfers, specify the
VMEbus source address with the -source <address> option.
To test memory to VME transfers, specify the -dest <address> options.
For VME to VME transfers , specify
both -source and -dest, and for memory to memory transfers,
specify neither. The default address mode is A32D32.

The default transfer size is 0x10000 bytes, unless the -size option is specified. The default number of transfers is 10, unless the -loops option is specified.

Other options are:

- size	- set size of each transfer
- loops	- set # of loops to run
- blt	- use block mode transfer
- retain	- use a retained buffer
- noblock	- run in non-blocking mode
- check	- check results every loop (not valid with -noblock)
- first	- only print first error in buffer
- help	- print the usage
- hold	- hold the DMA engine -- no other args are valid
- release	- release the DMA engine -- no other args are valid

The -retain options request the program to lock the user addresses in memory. This options makes repeated transfers more efficient.

A test session using the dmatest is given below.
The test system had a memory board on the VMEbus. The memory board was installed as an A32D32 board, with address range from 0x72a00000 to 0x749fffff.

```
# ./dmatest -help
Usage:
  ./dmatest [-hold] [-release] [-source <addr>] [-dest <addr>]
            [-size <count>] [-loops <loop_count>] [-blt] [-retain]
            [-noblock] [-check] [-first] [-help]

When -source or -dest is used, <addr> is a VMEbus address specifier,
as follows:

  [a{64,32,24}][d{64,32,16}:][<addrhi>.]<addrlo>
  <addrhi> is only required when a64 addresses are used.

Examples:
  a32:50000000          - VMEbus A32 address 0x50000000
  a24d16:500201f0       - VMEbus A32D16 address 0x500201f0
  a64d32:10.500201f0    - VMEbus A64D32 address 0x10500201f0

Other options are:
```

```
  -hold         - hold the DMA engine (no other options valid)
  -release      - release the DMA engine (no other options valid)
  -size         - set size of each transfer
  -loops        - set # of loops to run
  -blt          - use block mode transfer
  -retain       - use a retained buffer
  -noblock      - run in non-blocking mode
  -check        - check results every loop (not valid with -noblock)
  -help         - print the usage

#
#  ./dmatest -dest 0x72a00000 -size 0x1000 -loops 100
Starting 100 loops
Done.
Copied 400.000 KB in 0.180 seconds: 2222.222 KB/sec
#
#  ./dmatest -dest 0x72a00000 -size 0x1000 -loops 100 -retain
Starting 100 loops
Done.
Releasing retained buffer (id fc252208)
Copied 400.000 KB in 0.092 seconds: 4347.826 KB/sec
#
#  ./dmatest -source 0x72a00000 -loops 1000
Starting 1000 loops
Done.
Copied 64000.000 KB in 10.179 seconds: 6287.455 KB/sec
#
#  ./dmatest -source 0x72a00000 -loops 1000 -retain
Starting 1000 loops
Done.
Releasing retained buffer (id fc252c30)
Copied 64000.000 KB in 8.368 seconds: 7648.184 KB/sec
#
#  ./dmatest -source 0x72a00000 -dest 0x73a00000 -loops 1000 -retain
Starting 1000 loops
Done.
Releasing retained buffer (id fc252750)
Copied 64000.000 KB in 23.509 seconds: 2722.362 KB/sec
#
```

Writing Programs for the VMEbus 4

The software interface of the 10MP is transparently implemented under Solaris 1.x (SunOS 4.1.3) and Solaris 2.x. The software interface is fully compatible with generic Sun4m VME architecture systems. Any VME device driver that confirms to the appropriate Solaris Device Driver Interface will run unmodified on Themis platforms.

This guide is intended for system programmers who are not familiar with the Solaris architecture and the concepts of the VMEbus. The guide discusses the concepts of Solaris drivers and VMEbus devices as they pertain to the Themis SPARC 10MP product. The guide is intended as a general introduction of the basic concepts of using the Themis SPARC 10MP product under Solaris. The guide is not intended as a reference document. The reader may refer to other documents for more detailed information. Convenient access to the SPARC 10MP User Manual and the on-line manual pages for Solaris would be helpful while reading this manual.

Solaris 1.1.1 (SunOS 4.1.3) is Sun's legacy operating system. The VME drivers for Solaris 1.1.1 are provided on tape by Themis Computer. The transparent interface enables the running of any off-the-shelf application on the SPARC 10MP. Solaris 2.x family is a new generation of operating system that unifies Suns older BSD derived kernel and the newer UNIX SVR4 technology. The new operating systems add many new features like Symmetric Multiprocessing, Dynamically Loadable Drivers, etc.

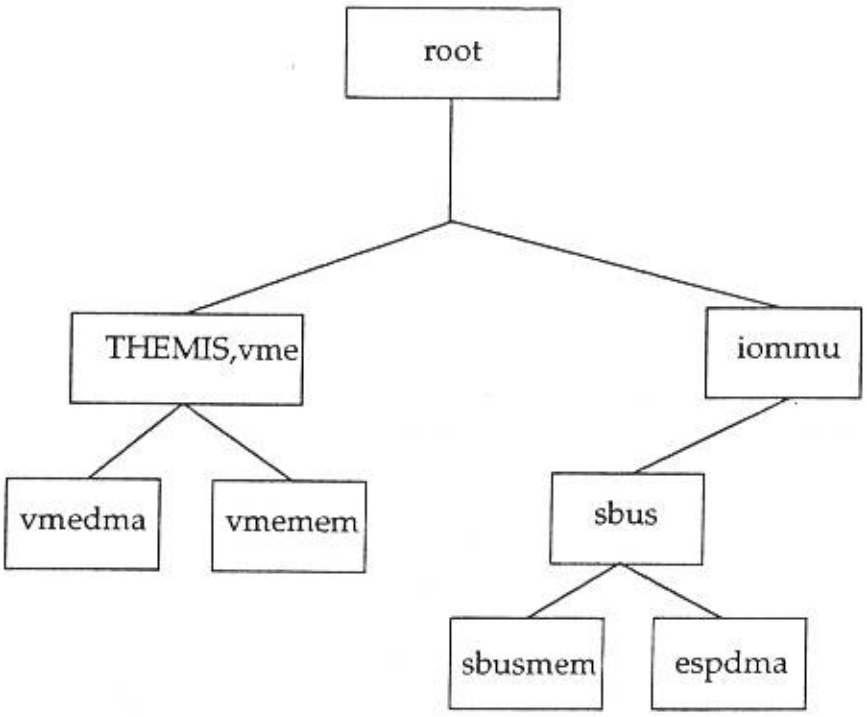
In its current version, this guide focuses on the software interface provided under Solaris 2.x. However, except for section 4.1, the material in this guide applies to Solaris 1.1.1 systems also.

4

4.1 *Solaris 2.x Device Hierarchy*

Solaris 2.x systems support architecture independence of devices by using a layered approach. Each node in the tree structure has a specific device function. Standard devices are associated with leaf nodes. The drivers for these devices are called leaf drivers. The intermediate nodes in the tree are associated with buses, like SBus, VMEbus etc. These nodes are called bus nexus nodes and the drivers associated with them are called bus nexus drivers. The bus nexus driver encapsulates all the architectural dependencies of a particular bus. The leaf driver only needs to know the kind of bus it is connected to.

On Themis SPARC10MP systems, the device tree looks like this:



In this diagram, root, iommu, THEMIS,vme and sbus are bus nexus drivers. The iommu encapsulates the features of the I/O Memory Management Unit found on sun4m systems. The vme driver encapsulates all the details of the implementation of the VMEbus interface. The vmemem driver, which is a leaf driver, only needs to know that it is connected to the VMEbus.

Solaris, like other UNIX systems, represents devices as special files in the file systems. These files are advertised by the device driver and are maintained by the drvconfig(1M) program. Usually the special files are created under the /devices directory and represent the hardware layout of a particular machine. sysdef(1) and prtconf(1) can be used to view the internal device tree. Symbolic links are created from the /dev directory to the special files in the /devices directory. User programs normally use the files from the /dev directory.

4.2 *Features of the VMEbus*

The VMEbus is an industry standard device interfacing bus that supports multiple address spaces. This means that a single VMEbus system can support devices that are 16-bit, 24-bit or 32-bit. There are many other features of the VMEbus which concern the system programmer. Another peripheral bus present in many SPARC platforms is the SBus.

VMEbus address space is not different from the physical memory space. A VMEbus address is indistinguishable from a memory address. Each card on the VMEbus has its own address. Usually this address is configurable. The address remains the same irrespective of the slot that the card is plugged into. In contrast, the SBus is geographically addressed; the address of a card is determined by the slot it is plugged into.

VMEbus supports multiple address spaces. A VMEbus system can support either 16,24 or 32 address bits and either 16 or 32 data bits. Some VMEbus cards can respond to multiple size of address bits. These cards must be configured for the desired access mode. Usually this configuration can be done by jumper settings. It is necessary for the device driver developer to specify the address space supported by the device in the hardware configuration file.

VMEbus devices are not self-identifying i.e. they do not provide information themselves to the system. Drivers for VMEbus devices need to have a probe() entry so that the kernel can determine if the device is really present. Additional information about the device must be provided in a hardware configuration file. See driver.conf(4) and vme(4) for more information.

VMEbus interrupts are vectored. When a device interrupts, it provides the priority as well as an interrupt vector. The kernel uses the information to uniquely identify the interrupt service routine to be called. The hardware configuration file must specify each priority-vector pair that the device may issue.

4.3 *Configuring the Software Interface of Themis SPARC 10MP*

TThe SPARC10MP board can be accessed in a slave mode from another board on the VMEbus chassis. This type of access requires specifying the slave base address and the size of the slave access region of the 10MP board. Distinct values can be specified for 24 bit addresses and 32 bit addresses. On a VMEbus chassis with multiple boards, each processor board is required to have a non-overlapping region for slave mode access. The OBP attribute vme32-slave-base and vme-boardid can be used to set the slave base addresses of a 10MP board.

The OBP attribute VME 32-Slave-base specifies the A32 slave base address. The OBP attribute vme-boardid specifies the higher byte of the A24 slave base address. i.e. A value of 2 for vme-boardid specifies a value of 0x20 0000 for the A24 slave base address. Please refer to section 7 for details on modifying OBp attributes.

4.4 *Accessing the VMEbus from Solaris*

This section describes the many features of the software interface provided by Themis Computer. The features provide the system programmer with powerful ways of accessing the VMEbus from the Solaris Operating System environment. Themis Computer has developed many sample programs that illustrate the ways of using the software interface provided by Themis. These programs are available with the source code. These programs can be used to test the configuration of a VME system; they can also be used as example programs for the use of the different features provided by the software interface.

The following subsections introduce the concepts of accessing the VMEbus from user programs. Each concept is fully illustrated by a sample program. The reader is strongly encouraged to review the sample programs while reading this guide. The programs can be freely modified in any way that the user wants to. For more information on running the sample programs, please

consult the document named 'Using the VME interface'. The reader may note that though the examples in this section use VMEbus memory boards, the usage can be extended to any type of VMEbus board.

4.4.1 *Using Read/Write*

The vmemem driver from Themis Computer enables the user to access any VMEbus address from a user program. Depending on the address space used by the particular VMEbus card, different devices need to be used.

Table 4-1 VME Table

File	Address Size	Data Transfer Size	Physical Address Range
/dev/vme16d16	16 bits	16 bits	0x0-0xFFFF
/dev/vme24d16	24 bits	16 bits	0x0-0xFFFFFF
/dev/vme32d16	32 bits	16 bits	0x0-0xFFFFFFFF
/dev/vme16d32	16 bits	32 bits	0x0-0xFFFF
/dev/vme24d32	24 bits	32 bits	0x0-0xFFFFFF
/dev/vme32d32	32 bits	32 bits	0x0-0xFFFFFFFF

e.g. to access a VME card that supports 24-bit addresses and 32-bit data transfers, the user needs to use the file /dev/vme24d32.

Using /dev/vmeXXdYY files is very similar to using normal files; the user program opens the file, uses the memory address as an offset to lseek to and does a read or write operation at the offset. The 'offset' must fall within the physical address range of the file that was opened; also there should be a VMEbus device that would respond to the address.

To access 16 bytes at the VMEbus address 0xa0000, the following code snippet can be used:

```
.
.
int fd;
int vme_base;
char buffer[16];

if ( ( fd = open( "/dev/vme24d32", O_RDWR)) < 0)
{
      perror("In opening file /dev/vme24d32");
      return(-1);
}

vme_base = 0xa0000;
if ( lseek ( fd, vme_base, SEEK_SET) < 0)
{
      perror("In lseeking to 0xa000");
      close(fd);
      return(-1);
}

if ( read ( fd, buffer, sizeof(buffer) ) != sizeof(buffer) )
{
      perror("In reading 16 bytes");
      close(fd);
      return(-1);
}
.
.
.
```

In the above example, if there is no device on the VMEbus at address 0xa0000, the VMEbus operation will time-out and the program would receive a SIGBUS signal.

The vmeXXdYY files can also be used to quickly check the proper installation of a VME board. e.g. After installing a VME memory board at address 0x72000000, the user can use od(1) to look at the memory:

```
> od -x /dev/vme32d32 +0x72000000
```

If the od command displays '0x72000000' and nothing else, it indicates that there is no VME device at the address 0x72000000.

Themis Computer provides the sample program vme_rw to illustrate the ways of accessing VMEbus addresses by using the vmeXXdYY files.

4.4.2 *Using mmap*

A faster way to access VMEbus space is to use the mmap(2) system call. mmap() establishes a mapping between the user process's address space and a memory object represented by an open file. The /dev/vmeXXdYY files can be used for mmap() as well. e.g. To access a region of length 1000 bytes in the VMEbus space, starting from location 0x500, the following code segment can be used:

```
.
.
.
int vme;
caddr_t pageptr;
.

if ((vme = open("/dev/vme32d32",O_RDWR)) < 0) {
        perror("open error on VME file");
        return;
}
```

```
if ((pageptr = mmap((caddr_t)0L, roundup( 1000, PAGESIZE),
            PROT_READ|PROT_WRITE, MAP_SHARED, vme,
            (off_t)(0x500 & PAGEMASK ))) == (caddr_t)-1) {
          perror("mmap error");
          return;
}
.
.
```

Note that the 'off' parameter to mmap() is constrained to be aligned at a page boundary. The 'len' parameter does not have a size or alignment constraint. The success of mmap() does not imply that the specified range of VMEbus is valid and accessible. If the region specified by [off, off+len] is not a valid VMEbus address region, access to the region will result in a SIGBUS signal. It is often convenient to catch this signal and take some action. The following code snippet sets up a catching mechanism for SIGBUS and SIGSEGV:

```
.
.
void busError(int sig_num )
{
printf("\nBus Error: received signal :%d\n", sig_num);
return(0);
}

.
.
main()
.
.
signal(SIGBUS, busError);
signal(SIGSEGV, busError);
.
.
```

Themis Computer provides a sample program named 'vme_mmap'. This program is a good example of using mmap() to handle regions of varying sizes. The program also handles bus errors generated by access to an invalid region. 'vme_mmap' can also be used to test a VMEbus board in a number of ways.

4.4.3 *DMA on the VMEbus*

Direct Memory Access is the process by which a device takes control of the bus and performs data transfers to (and from) main memory or other devices. The device does this work without the help of the CPU. DMA transfers occur at significantly higher speeds as compared to normal transfers using read()/write() or mmap().

On Themis SPRAC 10MP platforms, DMA access to the VMEbus is provided by the Newbridge SCV64 VMEbus Controller. The vmedma driver provides user access to the DMA features of the SCV64 controller. Using the ioctl interface provided by the driver, the user program can utilise the DMA engine and achieve high rates of data transfer.

Typically a DMA transfer occurs between memory and the VMEbus. The memory location is specified by a user virtual address that is usually obtained via malloc() or mmap(). The VMEbus location is specified by a physical VMEbus address. The VMEbus address space does not have to be mapped into user memory.

In addition to transfers between VMEbus and memory, the vmedma driver also supports transfers from memory to memory and VMEbus to VMEbus. Depending on the capabilities of the hardware platform, these transfers may be emulated in software.

The ioctl interface to the vmedma driver enables user programs to control the DMA transfer in a variety of ways. These include:

1. Specify the VME address space for source and destination (16-bit, 24-bit, 32-bit or 64-bit).
2. Specify the size of data transfer (16-bit, 32-bit, or 64-bit).

3. Specify whether Block Transfer mode will be used (Block Transfer mode is a feature of VMEbus in which the address information is placed only once at the beginning of the data transfer. Subsequent data transfers in the same block cycle automatically increment the addresses.)

4. Specify that the user buffers be locked into memory and any setup work done in the kernel be retained. The buffers are later released by the VIOCRELBUF ioctl command. This feature greatly increases the efficiency of repeated DMA transfers.

5. Specify that the user program not block awaiting the completion of the DMA transfer. Completion of the transfer is indicated to the user process by the generation of a SIGIO signal.

6. Interrogate the capabilities of the underlying hardware mechanism. e.g. on SpARC 10MP, memory to memory DMA transfers cannot be performed in hardware. The driver will emulate such a transfer in software. The VIOCGETCAP ioctl command provides the user program to determine details such as these.

The following code segment illustrates a simple DMA transfer from memory to VMEbus address 0x72a00000:

```
#include <themis/vmedmaio.h>

.
.
.

struct vme_dmacopy dma;/* DMA request structure */
int i;                                          /* loop counter */
int fd;                                         /* VME DMA engine fd */
long int * to_buf; /* memory buffer */
.
.
.

/* open the DMA engine */
if ((fd = open("/dev/vmedma0", O_RDWR)) < 0)
{
      (void) fprintf(stderr,"%s: can't open /dev/vmedma0: %s\n",
            argv[0],sys_errlist[errno]);
```

```
        exit(1);
}

/* allocate source memory buffer */
if ((to_buf = (long int *)malloc ( 1024 * sizeof(long))) == NULL)
{
        fprintf(stderr, "%s: can't allocate source memory buffer: %s\n",
                argv[0], sys_errlist[errno]);
        exit(1);
}

/* initialise the memory buffer with numbers from 0 to 1023 */
for ( i = 0; i < 1024; i++)
        to_buf[i] = i;



/* set up the DMA request
*                               - memory to VMEbus
*                               - 32-bit data, 32-bit address
*                               - no BLT
*                               - do not retain buffers
*/

dma.dma_source = to_buf; /* DMA transfer is from memory to VMEbus */
dma.dma_dest = (void *)0x72a00000;
dma.dma_sourcehi = dma.dma_desthi = 0; /* no 64-bit addresses */
dma.dma_count = 1024 * sizeof(long); /* length of data transfer */
dma.dma_result = NULL; /* we don't bother about the result area */

dma.dma_flags = VF_DVME; /* destination is VME; no other special stuff */

if ( ioctl(fd, VIOCDMACOPY, &dma) < 0) {
        fprintf(stderr, "%s: can't do DMA transfer: %s\n",
                argv[0], sys_errlist[errno]);
        free ( to_buf);
        exit(1);
}

free ( to_buf);
```

For VMEbus address spaces other than A32D32, the dma_flags needs to be properly set. .e.g for a DMA transfer from an A24D16 space toan A32D64 space, the flags are:

VF_SVME24 | VF_SVMED16 | VF_DVME | VF_DVMED64.

Themis Computer provides sample test programs that illustrate the use of the vmedma driver.

4.4.4 *Performing a Slave Mode Access to Another VME Board*

Memory on the SPARC10MP board can be accessed from another board on the VMEbus chassis. This type of access is called slave mode access. Slave mode access under Solaris is tied to the concept of Direct Virtual Memory Access (DVMA). DVMA is a facility present on SPARC hardware that allows a device driver to specify virtual addresses rather than physical addresses for a DMA operation. The kernel maintains a map that specifies the correspondence between the DVMA address and the physical memory.

In a typical operation, the master issues an address on the VMEbus; this address falls within the slave address range of another board on the chassis. The VME controller on the slave board then converts the VME address into a MBus virtual address. (For details on the conversion mechanism, refer to Section 6.2.5 of the SPARC10MP Technical Manual.) The VME controller then performs a DVMA operation on the MBus to access the physical memory location. The MBus virtual address generated by the VME slave access must be configured in the MVIC translation table. Themis Computer provides a driver that performs this configuration; the driver allocates a DVMA region and sets it up for VMEbus slave access at a particular VMEbus address. The master board simply uses this VMEbus address and generates a slave access operation on the VMEbus. The system that allocated the DVMA memory can also access the region by using special ioctl calls provided by the driver. Please refer to vmedvma(7) for more information on the driver.

The following code segment sets up a memory region of size 8192 bytes for DVMA access:

```
.
#include <themis/vmedvma.h>
.
.
.
int fd;
struct vme_dvmacopy dma_req;

   /* open the device */
if ((fd = open("/dev/vmedvma", O_RDWR))<0)
{
     perror("can't open /dev/vmedvma");
     exit(1);
}

/* allocate a DVMA region */
dma_req.size = 8192;
if (ioctl(fd, VDMA_ALLOCATE, &dma_req) != 0)
{
     perror("In allocating DVMA");
     close(fd);
     return(-1);
}

printf("Allocated a DVMA region id : %d, at virtual address : %x\n",
               dma_req.id, dma_req.addr);
```

The 'virtual address' output by this program can be used by other boards on the VMEbus chassis to gain access to this DVMA region. e.g. If a second board on the same chassis needs to access this region, one can execute this command:

> od -x /dev/vme24d32 {slave_address}

where {slave_address} is the virtual address output by the program.

The DVMA region can be accessed from the same system by invoking the ioctl() calls implemented by the vmedvma driver. The following code segment fills a DVMA region with zeros, starting from offset 0x500.

```
.
.
.
struct vme_dvmacopy dma_write;
char * buffer;
.
.
buffer = malloc( 4096);

dma_write.id = 1;
dma_write.addr= (caddr_t) buffer;
dma_write.size= 4096;
dma_write.offset= 2048;

if (ioctl(fd, VDMA_WRITE, &dma_write) != 0)
{
      perror("In initialising DVMA region");
      close(fd);
      return(-1);
}
.
.
.
```

Themis Computer provides the sample program vme_dvma that sets up a DVMA region for slave access. This region can then be accessed from another system on the VMEbus chassis using the vmeXXdYY files; the user can modify the contents of the region from one system and verify that both the systems share the same view of the contents of the region.

4.4.5 *Advanced Features of the VMEbus Interface*

The SPARC10MP product provides powerful advanced features like generating a SYSRESET on the VMEbus, configuring the interrupt mechanism etc. Themis Computer periodically issues Technical Notes that detail these interfaces and ways to access them. These Technical Notes have been put together in the document named "Advanced Configuration of SPARC 10MP". Please contact Themis Technical Support for issues not covered in that document.

Writing VME Device Drivers 5

A device driver is a kernel module responsible for managing low-level I/O operations for a particular hardware device. Some device drivers manage 'fake' devices that exist only in software. A device driver contains all the device-specific code to communicate with a device. Like the system call interface protects application programs from the specifics of the platform, the device drivers protect the kernel from the specifics of the devices. A device driver also provides a standard I/O interface to the rest of the system; i.e., a user program should be able to open a 'device file' and issue (in most cases a subset of) standard system calls to the file.

The VMEbus interface of Themis Computer's SPARC 10MP is transparently implemented under Solaris 1.x (SunOS 4.1.3) and Solaris 2.x. The software interface is fully compatible with generic Sun4m VME architecture systems. Any VME device driver that confirms to the appropriate Solaris Device Driver Interface will run unmodified on Themis platforms.

This guide is intended to highlight the VMEbus specific features that influence the design of drivers for VMEbus devices. It tries to provide basic information, and when needed, refers to sources for more detailed information on specific concepts. A full introduction to the principles of writing device drivers is beyond the scope of this guide. For information on writing device drivers for Solaris 1.x systems, please consult the document "Writing Device Drivers". The book "SunOS 5.3 Writing Device Drivers" has extensive information on writing device drivers for Solaris 2.x systems.

Themis Computer has developed a number of sample device drivers that illustrate the concepts covered in this chapter. Please see Chapter 8, Sample Device Drivers, for more information on the sample device drivers. These drivers, along with user level programs that interface to them, are provided in source code format.

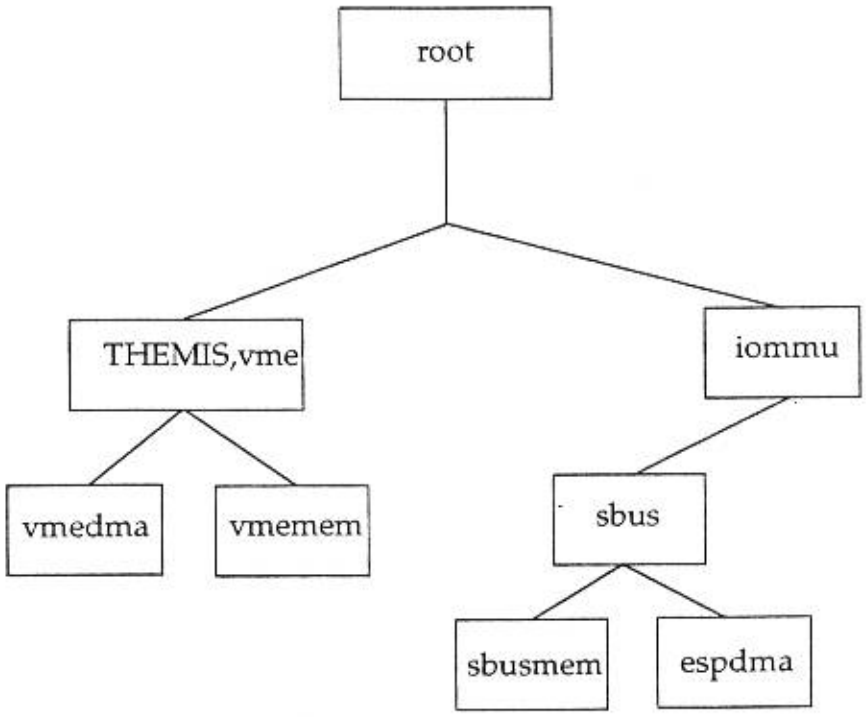
The last section in the guide discusses the situations where developing a custom device driver may not be necessary. The section discusses mechanism by which most device operations can be performed from the user level.

In its current version, this guide focuses on the software interface provided under Solaris 2.x. However except some sections, the concepts in this guide apply to Solaris 1.1.1 systems also.

5.1 Solaris 2.x Device Hierarchy

Solaris 2.x systems support architecture independence of devices by using a layered approach. Each node in the tree structure has a specific device function. Standard devices are associated with leaf nodes. The drivers for these devices are called leaf drivers. The intermediate nodes in the tree are associated with buses, like SBus, VMEbus etc. These nodes are called bus nexus nodes and the drivers associated with them are called bus nexus drivers. The bus nexus driver encapsulates all the architectural dependencies of a particular bus. The leaf driver only needs to know the kind of bus it is connected to.

On Themis SPARC10MP systems, the device tree looks like this:



In this diagram, root, iommu, vme and sbus are bus nexus drivers. The iommu encapsulates the features of the I/O Memory Management Unit found on sun4m systems. The vme driver encapsulates all the details of the implementation of the VMEbus interface. e.g. the vmemem driver, which is a leaf driver, only needs to know that it is connected to the VMEbus.

Solaris, like other UNIX systems, represents devices as special files in the file systems. These files are advertised by the device driver and are maintained by the drvconfig(1M) program. Usually the special files are created under the /devices directory and represent the hardware layout of a particular machine. sysdef(1) and prtconf(1) can be used to view the internal device tree. Symbolic links are created from the /dev directory to the special files in the /devices directory. User programs normally use the files from the /dev directory.

5.2 *Features of the VMEbus*

The VMEbus is an industry standard device interfacing bus that supports multiple address spaces. This means that a single VMEbus system can support devices that are 16-bit, 24-bit or 32-bit. There are many other features of the VMEbus which concern the system programmer. Another peripheral bus present in many SPARC platforms is the SBus.

VMEbus has many features that influence the design of device drivers written to operate on the bus. Some of these features require the VME board to be configured in a particular way. Some of the features require configuration from the Open Boot PROM. And some of the features need to be included in hardware configuration files for the device driver.

VMEbus address space is not different from the physical memory space. A VMEbus address is indistinguishable from a memory address. Each card on the VMEbus has its own address. Usually this address is configurable. The address remains the same irrespective of the slot that the card is plugged into. In contrast, the SBus is geographically addressed; the address of a card is determined by the slot it is plugged into.

VMEbus supports multiple address spaces. A VMEbus system can support either 16,24 or 32 address bits and either 16 or 32 data bits. Some VMEbus cards can respond to multiple sizes of address bits. These cards must be configured for the desired access mode. Usually this configuration can be done by jumper settings. It is necessary for the device driver developer to specify the address space supported by the device in the hardware configuration file.

VMEbus devices are not self-identifying i.e. they do not provide information themselves to the system. Drivers for VMEbus devices need to have a probe() entry so that the kernel can determine if the device is really present. Additional information about the device must be provided in a hardware configuration file. See driver.conf(4) and vme(4) for more information.

VMEbus interrupts are vectored. When a device interrupts, it provides the priority as well as an interrupt vector. The kernel uses the information to uniquely identify the interrupt service routine to be called. The hardware configuration file must specify each priority-vector pair that the device may issue.

5.3 *Configuration Files for VME Device Drivers*

Driver configuration files pass information about device drivers and their configuration to the system. Since VMEbus devices are not self-identifying, drivers for these devices need to use driver confi- guration files to inform the system that the device hardware may be present. The configuration file also must specify the device addresses on the VMEbus and any interrupt capabilities that the device may have. Please see driver.conf(4) and vme(4) for more details on the configuration files.

The syntax of an entry in the configuration file is:

```
name="driver name" class="vme" reg="...."
interrupts="...";
```

Specifying class as "vme" indicates to the kernel that the device driver is for a VMEbus device and should be attached to the bus nexus driver for VMEbus. On SPARC10MP systems, the bus nexus driver is named vme.

Two common properties of interest to VME device drivers are the reg and interrupts properties. The reg property is an array of 3-tuples: address space, offset and length. Each 3-tuple describes a contiguous resource (registers) that can be mapped. The value of the address space is derived from the following table:

Table 5-1 Address Space

Address Space	Value
A16D16	0x2d
A24D16	0x3d
A32D16	0xd
A16D32	0x6d
A24D32	0x7d
A32D32	0x4d

e.g. For a device that supports A24D32 and has a set of registers that are 32-byte long and start at address 0xee00, the following 3-tuple can be used: 0x7d, 0xee00,32. Multiple register sets are separated by commas.

VMEbus supports vectored interrupts. The interrupts property in the driver configuration file specifies all the interrupts that the device may generate. The interrupts property is an array of 2-tuples: VMEbus interrupt level, VMEbus vector number. e.g. for a device that generates interrupts at VME level 3 with a vector of 0x81, this two-tuple can be used: 2, 0x81. The VMEbus interrupt level has a value between 1 and 7, and the vector a value between 0 and 255.

All VMEbus device drivers must provide reg properties. The first two integer elements of this property are used to construct the address part of the device name under /devices. Only devices that generate interrupts need to provide interrupts properties.

It is to be noted that the DDI/DKI functions are capable of handling the VMEbus specific features, provided that the hardware configuration file is correct. e.g. if the hardware configuration file correctly defines a register set, the ddi_map_regs() function can be used to map the register set into kernel address space, without any extra effort from the driver code.

5.4 *Probing devices*

Since VME devices are not self-identifying, drivers for these devices are required to have a probe entry point. Usually the probe entry point tries to map the registers and then attempt to access the hardware using any of the peek and poke routines. The probe entry point should not initialize the device in anyway; it also should not initialise any of the software state.

Mapping registers from VMEbus space does not need any special considerations. The ddi_map_regs() function call can be used to map the registers; this function will take care of the VMEbus address space that the register set is in.

The following code segment is an example of mapping a register set and 'carefully' accessing a byte in the set.

```
/*
 * xxprobe          - probe for this device
 */
static int
xxprobe(dev_info_t *dip)
{
     struct my_reg_str *regs; /* Device registers */
     caddr_t kaddr;        /* mapped register address */
     int retval;           /* return value */

     /*
      * If we're self-identifying, then we're here.
      */
     if (ddi_dev_is_sid(dip) == DDI_SUCCESS)
          return DDI_PROBE_SUCCESS;

     /*
      * Probe the device by mapping the registers, and reading the
      * command register and the parm7 register...This assures that
      * *something* is there.  The attach routine will try to run
     * more rigorous checks. So this simple check is all we
      * really need here.
      */
     if ((retval = ddi_map_regs(dip, 0, &kaddr, 0, 0)) != DDI_SUCCESS) {
         cmn_err(CE_WARN,"xx%d(probe): can't map my registers, error%d\n",
               ddi_get_instance(dip), retval);
          return DDI_PROBE_FAILURE;
     }

     regs = (struct my_reg_str *)kaddr;
     retval = ddi_peekl(dip, (long *)&regs->command, (long *)0)
             == DDI_SUCCESS ? DDI_PROBE_SUCCESS : DDI_PROBE_FAILURE;

     if (retval == DDI_PROBE_SUCCESS)
          retval = ddi_peekl(dip, (long *)&regs->parm7, (long *)0)
                  == DDI_SUCCESS ? DDI_PROBE_SUCCESS : DDI_PROBE_FAILURE;

     ddi_unmap_regs(dip, 0, &kaddr, 0, 0);

     return retval;
```

5.5 *Registering Interrupts*

VMEbus interrupts are vectored. When a device interrupts, it provides the priority as well as an interrupt vector. The kernel uses the information to uniquely identify the interrupt service routine to be called. The hardware configuration file must specify each priority-vector pair that the device may issue. Once this has been done, the driver code can call the ddi_add_intr() function to register the interrupts. On return from this function, the fourth arguemnt contains a pointer to useful information like theVMEbus interrupt priority and the VMEbus vector number.

The following code segment provides an example of registering an interrupt with the kernel; the code first gets the number of interrupt specification in the configuration file; then it registers an interrupt handler for each interrupt specification.

```
static int
xxattach(dev_info_t * dip, ddi_attach_cmd_t cmd)
{
struct xxstat * xsp;
int nbint,i;
.

if ( cmd != DDI_ATTACH)
return (DDI_FAILURE);
.
.
/* get the number of interrupt definitions */
if (ddi_dev_nintrs(devi, &nbint) == DDI_FAILURE)
{
      cmn_err(CE_WARN,"xx: No interrupts property.");
      return (DDI_FAILURE);
}

for ( i=0; i < nbint; i++)
{
/* Register first with a null handler so that the interrupt
 * routine doesn't grab the mutex
 */
      if ( ddi_add_intr(dip, i, &xsp->iblock_cookie[i],NULL,
```

```
        ( (u_int (*) (caddr_t) nulldev, NULL) != DDI_SUCCESS)

    {
        cmn_err(CE_WARN,"xx: cannot register interrupt.");
        return (DDI_FAILURE);
    }

    /* Initialise the mutex now. */
    mutex_init ( &xsp->mu, "xx mutex", MUTEX_DRIVER,
    (void *) xsp->iblock_cookie[i]);

    /* Remove the interrupt and register again with the correct
     * interrupt handler.
     */
    ddi_remove_intr ( dip, i, xsp->iblock_cookie[i]);
    if ( ddi_add_intr(dip, i, &xsp->iblock_cookie[i],
        &xsp->idevice_cookie[i], xxintr, NULL) != DDI_SUCCESS)

    {
        cmn_err(CE_WARN,"xx: cannot register interrupt.");
        return (DDI_FAILURE);
    }

    cmn_err (CE_NOTE,"Registered interrupt %d with priority %d and
            vector 0x%x",
        i, xsp->idevice_cookie[i].idev_priority,
        xsp->idevice_cookie[i].idev_vector);
}
.
.
```

Themis Computer provides a sample device driver, vmeintr, to illustrate the use of interrupts in device drivers. This driver is provided along with the source code and a sample configuration file. The reader may wish to study the source code for this driver to gain a better understanding of handling interrupts in device drivers.

5.6 *Allocating DVMA Space*

Direct Virtual Memory Access is a facility present on SPARC hardware that allows a device to specify virtual addresses rather than physical addresses for a DMA operation.

The kernel maintains a map that specifies the correspondence between the DVMA address and the physical memory. It is the responsibility of the device driver to set up the memory region for DVMA access.

Setting up a DVMA region is a two-step process: allocating memory and allocating DMA resources for this memory region. The following code segment is an example of setting up a DVMA region of size 'len' bytes.

While allocating memory and setting it up for DVMA, the driver can describe the capabilities of the DMA engine to the kernel by using a ddi_dma_lim_t structure. On SPARC10MP systems, the capabilities are as follows:

```
.
static ddi_dma_lim_t limits =
{
0x0,
0xffffffff,
0xffffffff,
07f,
0x1,
0
};
.
.
caddr_t kmem_base;
int req_id, real_len, req_len;
ddi_dma_handle_t handle;
ddi_dma_cookie_t cookie;
dma_req_t *reqp;
.
.
req_len = len;
real_len = 0;

/* allocate memory */
```

```
    if (ddi_mem_alloc (xsp->dip, &limits,
                (size_t)req_len, 0, &kmem_base,
                (uint *) &real_len) != DDI_SUCCESS)
    {
         cmn_err (CE_NOTE, "ddi_mem_alloc failed.");
         return (ENOMEM);
    }

/* set it up for DMA access */
    if (ddi_dma_addr_setup (xsp->dip, (struct as *) NULL,
         kmem_base, real_len,
         DDI_DMA_RDWR, DDI_DMA_DONTWAIT, 0, &limits,
         &handle) != DDI_DMA_MAPPED)
    {
         ddi_mem_free (kmem_base);
         cmn_err (CE_NOTE, "ddi_dma_addr_setup failed.");
         return (EFAULT);
    }

/* extract the virtual address of the memory region.
 * this can be obtained from the DMA cookie structure.
 */

    if (ddi_dma_htoc (handle, 0, &cookie) != DDI_SUCCESS
         ||
         ddi_dma_sync (handle, 0, real_len, DDI_DMA_SYNC_FORDEV)
         != DDI_SUCCESS)
    {
         ddi_dma_free (handle);
         ddi_mem_free (kmem_base);
         cmn_err (CE_NOTE, " ddi_dma_sync() failed\n");
         return (EFAULT);
    }

     cmn_err ( CE_NOTE,"Virtual address of memory  is 0x%x",kmem_base);
     cmn_err ( CE_NOTE,"Virtual address of the DVMA region is 0x%x",
          (caddr_t) cookie.dmac_address );
.
.
.
```

The address contained in the 'DMA cookie' is the 'virtual address' of the DVMA memory region and can be used to access the memory region over the VMEbus. e.g. if the 'virtual address' printed by the second cmn_err statement is 0x588, you can access this memory region from another system on the VMEbus chassis by using this command:

```
# od -x /dev/vme24d32 0x588
```

Themis Computer provides a sample device driver, vmedvma, to illustrate the use of DVMA in VME device drivers. This driver is provided along with the source code and a sample configuration file. The reader may wish to study the source code for this driver to gain a better understanding of using DVMA from device drivers.

5.7 *Mapping VMEbus Space*

On some occasions, it would be convenient to map a chunk of VMEbus address space into the system's memory. From the user level, this can be done by doing a mmap() operation on the appropriate /dev/vmeXXdYY file. From the driver level, mapping VMEbus address space can be done by using the ddi_map_regs() function. e.g. to map two pages of VMEbus space starting at location 0x66600000, the following code segment can be used:

```
if (ddi_map_regs(dip, 0, &map_space, 0x66000000, (off_t) 8192) !=
                DDI_SUCCESS)
{
                return (EFAULT);
}
```

On return from the function, map_space contains the base address of the kernel virtual region.

There are many caveats to using ddi_map_regs() to map a portion of VMEbus address space.

1. An A32D32 device can only map a chunk from A32D32 address space.

2. The address space indicated by [offset, offset+len] must be a valid region on the VMEbus.

3. Access to the mapped region should be localized. Subsequent access to locations that are far apart will result in many page faults, particularly on regions of larger sizes.

It is prudent to use the ddi_peek() and ddi_poke() routines to access a region mapped using ddi_map_regs().

5.8 *Driving Devices Without Writing Device Drivers*

As mentioned before, device drivers protect the rest of the kernel from the specifics of hardware devices. Most hardware devices would necessiate the development of a device driver before they can be used on a computer system. However the features of the VMEbus and the design and implementation of the Themis Computer software interface for VME alleviate the need for specialised device drivers for most simple VME devices. This provides a tremendous advantage to programmers writing applications for these simple devices.

In Solaris 2.x device drivers are dynamically loadable. This avoids the need to relink the kernel and reboot the system whenever a driver is modified. However, a fault in the driver could stil cause the kernel to panic, resulting in long downtimes for the machine. Further, an abnormal shutdown of the machine, as in the case of kernel panic, could cause the disk to be corrupted and some important files to be lost. These problems cna be avoided if the program driving the device executes in user mode instead of kernel mode.

This section discusses some ways by which an user program can do device operations that are traditionally performed by a device driver. The section is intended to clue the programmer on to the possibilities of accessing devices from user level. The reader is encouraged to go through the source code of the sample drivers to gain an insight into how they can be used for user-level access.

In simplistic terms, a device can be viewed as a collection of registers that are addressable. Almost all of these registers can be either read from or written to. Some of them allow both read and write access. Access to many of the registers results in effects like resetting the value of the register, clearing the interrupt etc. Some registers require a particular sequence of accessing them. Some registers have specific data widths that can be used to access them. Though

there are some devices that have some very peculiar behavior, most devices can be modeled as a collection of registers. Such devices, if they are VMEbus devices, can be programmed and used without the need for a specialised device driver.

As mentioned before, VMEbus addresses are not distinguishable from memory addresses. The vmemem drivers from Themis Computer, which is the device driver for the /dev/vmexxdyy files, enables an user program to access any address in the VMEbus space.

This feature can be used to access the registers of a device from a user program. The user program needs to open the appropriate /dev/vmeXXdYY file, lseek to the address of the device registers and do a read or write operation. The vmemem driver performs the read/write opeartion 'carefully' by using the ddi_peek() and ddi_poke() calls. If the user program opens the appropriate file and the read/write access meets the alignment criteria of the device, the device registers can be easily programmed from the user program.

.e.g To access a device that supports 32 address bits and has 32-bit data, with the registers starting at offset 0x7e000000, the user program needs to open /dev/vme32d32 and lseek to offset 0x7e000000. Please note that the registers of this device could be 8-bit wide, 16-bit wide or 32-bit wide. If the read/write call is issued with the appropriate length, the vmemem driver will issue the appropriate ddi_peek or ddi_poke call.

Note that the mmap() interface of the vmemem driver does not use the ddi_peek/ddi_poke calls. In such cases, acces to all non-existent address space will cause a SIGBUS signal to be sent to the user program.

The vme DVMA driver provided by Themis can be used to support more powerful devices that are capable of performing DMA operations on the VMEbus. e.g. To program a device to perform a DMA operation to on-board memory space, the user program can do the following:

1. Open the relevant /dev/vmeXXdyy file and lseek to the beginning of the register space.
2. Open /dev/vmedvma and allocate a DVMA region.
3. Use the virtual address returned by the allocate ioctl to program the DMA engine on the device.
4. Use the other ioctls provided by the vmedvma driver to access the DVMA region.

Devices that issue interrupts pose more of a problem when accessed from the user level. In some cases the devices can be programmed to not raise interrupts. Input/output in such cases may be done by making the user program 'busy-wait'. In other cases, the vmeintr driver can be used to receive the interrupt and signal a user program when the interrupt is raised. The user program can then look at the device registers and take appropriate actions.

Future releases from Themis Computer will include a "user level driver" that can be used to program a simple device.

SPARC 10MP Programmers Guide 6

6.1 Introduction

This guide is intended to provide helpful information and tips to systems programmers who use the Themis SPARC 10MP boards. The next section is intended to address the programmers who wish to program the Themis SPARC 10MP board for the VMEBus without the aid of an operating system or real-time kernel. Further sections are intended to address the programmers who wish to access the Themis SPARC 10MP board from any of the supported Operating System environments.

Detailed information concerning on-board device interfaces, memory maps and device accesses are contained in the appendices and should be consulted while reading this guide.

The Themis SPARC 10MP processor board implements a Sun SPARCstation10 compatible workstation on a single- or double-width 6U VMEbus board. A full VME master/slave interface is included, using the Fujitsu MBus to VMEbus Interface Controller.

This guide is primarily concerned with the implementation and programming of 10MP that are not common to the superSPARC family of workstations (SPARCstation 10).

6.2 *Overview of VME Interface Under Solaris 1.1.1B/2.X*

Great effort has been expended to achieve complete compatibility between Sun VME implementations and the device driver interface implemented for the 10MP board under Solaris.

This section is primarly concerned with the implementation and programming of 10MP specific features that are not common to the microSPARC II family of workstations (SPARCstation 5). It assumes that the reader is familiar with the sun4m architecture and the concepts of VMEbus and device drivers. A separate tutorial provides more detailed information for readers who are not familiar with these concepts.

The VMEbus interface of the 10MP is transparently implemented under Solaris 1.X (SunOS 4.1.3) and Solaris 2.X. The software interface is fully compatible with generic Sun4m VME architecture systems. Any VME device driver that confirms to the appropriate Solaris Device Driver Interface will run unmodified on Themis platforms.

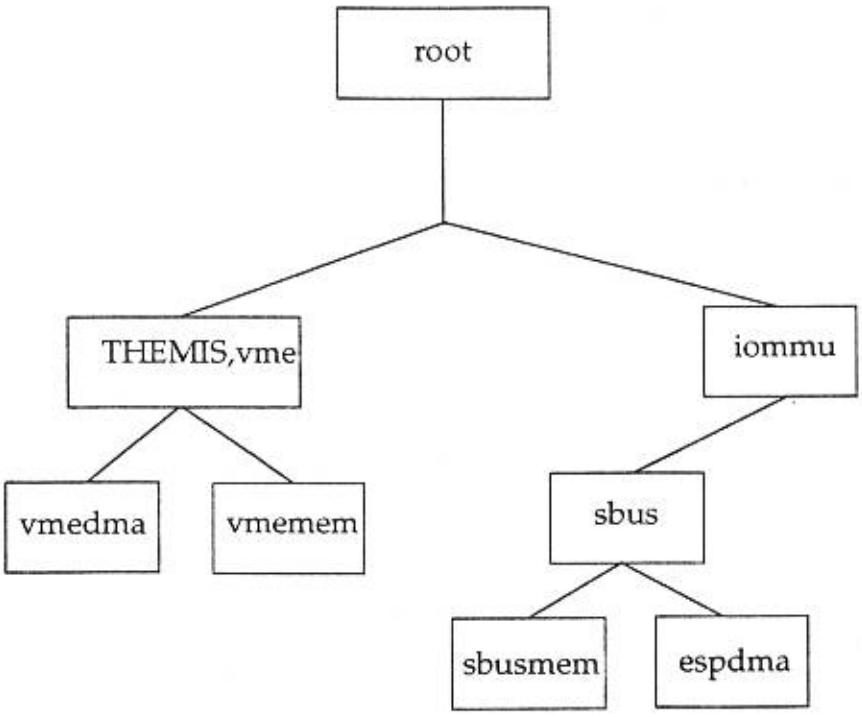
Themis Computer has developed a number of device drivers to provide the necessary software interface needed by system programmers. The drivers can be classified into three categories:

- VMEbus Nexus drivers
- Utility drivers
- Sample drivers

The drivers are described in the following subsections. Themis also provides online manual pages for all the drivers included in the software interface. These manual pages include more detailed information on the drivers.

6.2.1 *VMEbus Nexus Driver*

The tvme driver forms the core of the software interface provided by Themis Computer. tvme is a bus nexus driver that encapsulates all the architectural features of supporting the Themis 10MP board on Solaris systems. This driver is configured to be permanently loaded as the bus nexus driver for the VMEbus.



Any driver that specifies its class or parent as vme will be attached to the vme driver. The vme driver provides support for all VMEbus operations, including VME interrupt processing, Direct Virtual Memory Access (DVMA) on the VMEbus, mapping of registers on the VMEbus to kernel space, mapping of VMEbus memory to user address space through mmap(), etc.

The tvme nexus driver also exports certain capabilities that can be used by VMEbus leaf drivers. This enables leaf drivers to perform operations like Direct Memory Access in a very efficient manner.

The tvme driver recongnizes the standard configuration file for VME device drivers. (see vme(4)). The configuration of any vme device driver specifies the VMEBus interrupt level and the interrupt vector. The mapping of the VMEbus interrupt level to the SPARC interrupt priority level is as follows:

Table 6-1 VMEbus Interrupt Mapping

VMEBus		1	2	3	4	5	6	7
SPARC ip	1	2	3	5	7	9	11	13

6.2.2 *Utility Drivers*

These drivers are a standard part of the software interface provided by Themis Computer. These drivers provide a useful interface to system programmers who wish to utilize the different features of the VMEbus architecture.

The vmemem device driver provides the standard `/dev` devices for accessing the VMEbus from user processes:

Table 6-2 VME Device Drivers

Device File	Address Size	Data Transfer Size
/dev/vme32d32	32	32
/dev/vme32d16	32	16
/dev/vme24d32	24	32
/dev/vme24d16	24	16
/dev/vme16d32	16	32
/dev/vme16d16	16	16

Read(), write() and mmap() calls are supported and no special ioctl() calls are required to configure the interface. VME interface configuration is performed under OBP and should not be modified while the operating system is running.

On Themis SPRAC 10MP platforms, DMA access to the VMEbus is provided by the Fujitsu MVIC. The vmedma driver provides user access to the DMA features of the MVIC. Using the ioctl interface provided by the driver, the user program can utilise the DMA engine and achieve high rates of data transfer.

6.2.3 *Sample Drivers*

The software interface provided for the 10MP platform fully supports standard VMEbus device drivers written for Solaris environments. It is the intention of Themis Computer to fully support users who wish to write their own VME device drivers that would function on Themis SPARC 10MP platforms. To aid these users and to illustrate the specific features of the VMEbus architecture, Them provides a number of sample device drivers. Themis provides the complete source code and the necessary configuration files for these drivers.

- vmeintr: is a sample driver provided by Themis Computer to illustrate the vectored interrupt mechanism of the VMEbus. The vmeintr driver relies on the driver configuration files to specify the interrupts it should handle. Each instance of the driver registers the interrupts with the system. Through the ioctls implemented by the driver, the user can generate interrupts and send them to the appropriate driver instances. The interrupt generator and the interrupt receiver need to run on different computers.

- vmedvma: is a sample driver provided by Themis Computer to illustrate the use of Direct Virtual Memory Access within a device driver. The user can ask the driver to allocate a DMA region on the VMEbus. The driver allocates all the necessary resources to support a DVMA transfer to this region. The driver also implements mechanisms by which the user program can writer to or read from the DVMA region.

- simpledma: is a sample driver provided by Themis Computer to illustrate the use of Direct Memory Access within a device driver. It is a simplified version of the standard vmedma driver. This driver is mainly intended for programmers writing device drivers that perform DMA operations on the VMEbus.

Advanced Configuration of 10MP 7

The SPARC 10MP product provides powerful advanced features like generating a SYSRESET on the VMEbus, configuring the interrupt mechanism etc. Themis Computer periodically issues Technical Notes that detail these interfaces and ways to access them. These Technical Notes have been put together in this document. Please contact Themis Computer Technical Support for advanced configuration topics not covered in this document.

Some of the sections in this chapter may apply to other Themis Computer products too. These are noted as applicable.

7.1 Disabling VMEbus Interrupts

TECHNICAL NOTE No 107-01
SUBJECT: Disable VME interrupts on THEMIS boards
BOARD: All
O.S.: all (except solaris 1.x on the LXE) (*)
Hardware rev: all
DATE: April 20, 1995

Problem: By default, VME interrupts are enabled on THEMIS boards. This can cause conflicts on the VMEbus, in multi CPU configuration, as there may be more than one interrupt handler for one particular VME interrupt level.

Boards: all
Operating system:all Solaris, except 1.1 for LXE.

Programming of VME interrupt mask is done under OBP, using nvramrc commands :

THEMIS LXE:

-=-=-=-=-=-=-

```
ok nvedit
1: xx 5ffe.0014 20 spacec!
2: ^C
ok nvstore
ok setenv use-nvramrc? true
ok reset
```

VME BUS interrupt mask register 0x5ffe0014 is as follows:
-bit [7..1] : Vme IRQ 1..7. If set IRQ is enabled.
-bit 0 : Arbitration mode. 0 = Single level, 1 = Round robin

So, if xx is 0xfe (default), all interrupts are enabled, and VMEbus arbiter operates on single level (Bus level 3).

THEMIS LXE+ and 5-64:

-=-=-=-=-=-=-=-=-=-=-=-=

```
ok nvedit
1: xx 7d00.00b0 20 spacel!
2: ^C
ok nvstore
ok setenv use-nvramrc? true
ok reset
```

VME BUS interrupt mask register description is as follows:

- bit 6:VME IRQ7

  .....

- bit 0:VME IRQ1

(*) On the LXE running solaris 1.x, you need to disable interrupts from UNIX, after the system is booted. Please contact Technical support for details.

7.2 *Isolating Boards from VMEbus SYSRESET*

TECHNICAL NOTE No 120-00
SUBJECT: Isolate board from VME SYSRESET.
BOARD: THEMIS LXEplus,5-64, 10MP
O.S.: all
Hardware rev: all
DATE: May 9, 1995

It can be useful to isolate a VME board from the VME sysreset signal, especially if you are running Solaris.

To isolate the Themis 5-64, or the LXEplus from the VME sysreset, you have to remove a CMS resistor (R5500). After removing that resistor which is in fact a short (0 Ohms), the board will be disconnected from the VME sysreset signal. In case you want to connect the board to the sysreset signal again, use a solder bead to short R5500.

NB:The location of R5500 is different on the 5-64 and the LXEplus. Please see drawings enclosed.

To isolate the 10MP from SYSRESET, you need to change the socketed PAL U2309 with a special PAL. Please contact Technical support to get that PAL. Note that after that modification, the 10MP won't receive SYSRESET from other boards, but will still be able to send it on the bus.

7.3 *Handling Data Mismatch Over the VMEbus*

TECHNICAL NOTE No 133-00
SUBJECT: Data mismatch over the VME.
BOARD: THEMIS 10MP
O.S.: Solaris 2.4
Hardware rev: all
DATE: July 1, 1995

There is a bug in solaris 2.4, in the way the MicroSparcII MMU is handled. This bug can result in data mismatch over the VME. Typically, you won't read back the same value that you write to a given VME memory range, especially if you make transfers of more that one MMU page (4k).

The solution is to apply the Sun 101945 kernel jumbo patch. This is quite a big patch(16MB), and Themis is shipping it along with the 10MP VME nexus driver.

To apply it, you simply need to run the ./installpatch command at the patch directory level:

```
# cd 101945-27
# ./installpatch .
```

To check if you already installed that patch, you need to run the following command:

```
# showrev -p
```

This will tell you what patches were already installed on your system.

7.4 *Handling VMEbus Lock-Up Problems*

TECHNICAL NOTE No 137-00
SUBJECT: VME lock-up problem on the 10MP
BOARD: All
O.S.: all
Hardware rev: all with C4 KSIC (and before)
DATE: October 18, 1995
STATUS:

There is a potential problem on the 10MP that after heavy SBUS and VME traffic, the board can no longer access VME.

The problem is that the VMMU, in charge of translating SBUS addresses to VME addresses, is disabled at random times. Thus no further VME access is possible, and the CPU gets a bus error that will crash the system if the access is made by kernel code (device driver).

The solution is to use the C5 KSIC (and above versions). This KSIC is actually disabling accesses to the VMMU registers, preventing the VMMU to get disabled.

Note: How to check the version of your KSIC:

->Please check the revision number that is written onto the KSIC iteself (Right in the middle of the 2 SBUS connectors).

7.5 *Configuring VMEbus Release Mode*

TECHNICAL NOTE No 122-00
SUBJECT: VME release mode. ROR vs RWD
BOARD: THEMIS LXEplus,10MP
O.S.: all
Hardware rev: all
DATE: Oct 19, 1995

When a MASTER VME board wants to make a VME BUS cycle it has to request theVMEBUS from the bus controller (SYSCON). Then when the cycle is done, it will release the VMEbus, so that other MASTERS on the VME can request and be granted the VMEBUS.

There are 2 modes of releasing the VMEbus:
-ROR: Release on request.
-RWD: Release when done.

-In ROR mode the MASTER VME board will keep ownership of the VMEBUS (i.e.keep BBSY asserted), until another MASTER request the VMEBUS. But one should be aware that this could result in VMEBUS starvation for every board located to the left of any ROR master. This is due to the fact that the SYSCON is granting ownership of the VMEBUS using the BUS GRANT daisy chain signals. Those signals are propagated from left to right of the chassis, starting from the SYSCON to the next VME board (board #1). If that next board is requesting the VMEBUS then it will consider it has been granted the VMEBUS by the SYSCON.

Otherwise, it will pass the BUS GRANT daisy chain signal to the next board on its right(board #2).

Now if board #1 is programmed in ROR mode,

-In RWD mode, the MASTER VME board releases the VMEBUS as soon as the VME cycle it just performed is done.

How to program your board to switch to coupled mode:

Themis 10MP and LXEplus:
==========

The default mode is RWD. Here is how to set the board in ROR mode.

You have to use OBP nvedit feature to add a FORTH command, that will be ran each time the board is booted.

```
ok nvedit
1: 7d00.0090 20 spacel@ df and 7d00.0090 20 spacel!
2: ^C
ok nvstore
ok setenv use-nvramrc? true
ok reset
```

4. Edit /etc/hosts and add an entry for the client:

```
#
# Sun Host Database
#
# If the NIS is running, this file is only consulted when booting
#
127.0.0.1        localhost
#
198.211.242.189 mp112 loghost
198.211.242.188 564_1
~
"/etc/hosts" 9 lines, 167 characters
```

5. Same thing under /etc/ethers (tftpboot)

```
0:80:b6:1:2:3    564_1
~
"/etc/ethers" [New file] 1 line, 20 characters
```

6. Run add_client:

```
mp112# /usr/etc/install/add_client -i
```

```
CLIENT FORM                [?=help] [DEL=erase one char] [RET=end of
            input data]
-------------------------------------------------------------------------
            -----
Architecture Type : x[sun4m.sunos.4.1.4]
Client name       : 564_1
Choice            : x[create]  [delete]  [display]  [edit]
Root fs : /export/root (sd0a)              144616448   Hog : sd0h   0
Swap fs : /export/swap (sd0a)              144616448   Hog : sd0h   0

Client Information :
      Internet Address              : 198.211.242.188
      Ethernet Address              : 0:80:b6:1:2:3
      NIS Type                       : x[none]  [client]

      Swap size (e.g. 8B, 8K, 8M) : 16M
      Path to Root                  : /export/root/564_1
      Path to Swap                  : /export/swap/564_1
      Path to Executables          : /usr
      Path to Kernel Executables  : /export/exec/kvm/sun4m.sunos.4.1.4
      Path to Home                  : /home/mp112
      Terminal type                 : sun

Ok to use these values [y/n] ?
    [x/X=select choice] [space=next choice] [^B/^P=backward]
            [^F/^N=forward]
```

7.6 *Installing Solaris 1.x Patches on Diskless Clients*

TECHNICAL NOTE No 145-00
SUBJECT: Homogeneous server: Client install problem.
BOARD: THEMIS LXEplus,10MP
O.S.: Solaris 1
Hardware rev: all
DATE: Nov, 1995

Themis VME boards are sometimes configured as a client diskless node. They use tftpboot, to boot from a Sun server machine. Then they mount their /root, /swap, /usr and /home file systems from a remote disk, using NFS. That kind of configuration can sometimes cause a problem, when installing the VME patch, that will permit the Themis board to access the VME bus:

Under Solaris 1, VME software is provided under the form of modified Kernel binaries, not true device drivers like under solaris 2.4. So, applying the VME patch on the NFS mounted partitions of the client, may sometimes result in patching some important kernel binaries on the server itself.

The VME patch is only updating files located in the /usr/kvm directory, also known as the "kernel binaries".So, it is of the utmost importance to configure the client with a separate /usr/kvm directory than that of the server. In the case, where the diskless and the server are running 2 different versions of Solaris 1 (let's say solaris 1.1.2 and Solaris 1.1.1B), there is no problem, as in this case, running "add_services" will generate a /usr/kvm (kernel binaries) unique to the the client diskless. This directory will actually be located in: /export/exec/sun4m.sunos.4.1.4.

But in the case where the client and the server are running the exact same version of the Solaris 1 Operating system, "add_services" won't let you install a separate /usr/kvm for the client. Themis is currently in contact with SunSoft, to find a solution to that problem.

In the meantime, there is a workaround to install, let's say a Solaris 1.1.2 diskless client on a Solaris 1.1.2 server machine.

(in the example below, mp112 is the server, and 564_1 is the client.)

1. During the Sysgen of the server, don't forget to configure that machine as a server (versus a stand alone system).
2. Under /export/exec/kvm/ directory, remove the sun4m.sunos.4.1.4 directory (actually a link to /usr/kvm).
3. Copy /usr/kvm in /export/exec/kvm/sun4m.sunos.4.1.4.

```
mp112# cd /usr/kvm
mp112# tar cvf /tmp/kvm .
mp112# cd /export/exec/kvm
mp112# mkdir sun4m.sunos.4.1.4
mp112# cd /export/exec/kvm/sun4m.sunos.4.1.4
mp112# tar xvf /tmp/kvm
mp112# ls
adb                     libkvmn.so.0.3pstat     sys
arch                    libkvm_p.a  showrev     trace
boot                    m68k        sparc       u370
config                  machine     stand       u3b
crash                   mc68010     sun         u3b15
eeprom                  mc68020     sun2        u3b2
format                  mdec        sun3        u3b5
fuser                   modload     sun386      unixname2bootname
getcons                 mps         sun3x       vax
i386                    mpstat      sun4        w
iAPX286                 pdp11       sun4c
libkvm.a                ps          sun4m
```

```
Creating client '564_1'

Updating the server's databases
Setting up server file system to support client
Making client's swap file
Setting up client's file system
Copying /export/exec/proto.root.sunos.4.1.4 to /export/root/564_1
Copying binaries

Updating client's databases
Setting up Client's ttytab

7. On the server: Declare /export/exec/kvm/sun4m.sunos.4.1.4
in /etc/exports:
(check line #6)


/usr
/home
/var/spool/mail
/export/root/564_1        -access=564_1,root=564_1
/export/swap/564_1        -access=564_1,root=564_1
/export/exec/kvm/sun4m.sunos.4.1.4 -rw=564_1,access=564_1,root=564_1
~
~
"/etc/exports" 6 lines, 184 characters
```

8. Update the client's /etc/fstab file:

```
mp112:/export/root/564_1          / nfs rw 0 0
mp112:/export/exec/sun4.sunos.4.1.4      /usr nfs ro 0 0
mp112:/export/exec/kvm/sun4m.sunos.4.1.4          /usr/kvm nfs rw ro 0 0
mp112:/home/mp112         /home/mp112 nfs rw 0 0
mp112:/var/spool/mail    /var/spool/mail nfs rw 0 0
mp112:/export/share/sunos.4.1.4 /usr/share nfs rw 0 0
~
~
"/etc/fstab" 6 lines, 298 characters
```

9. Boot the client:

```
ok boot net
Resetting ...

zs is initialized
Initializing TLB
Initializing Swift Cache

Allocating SRMMU Context Table
Setting SRMMU Context Register
Setting SRMMU Context Table Pointer Register
Allocating SRMMU Level 1 Table
Level 1 Table allocated, Available Memory 0x03feec00

Mapping RAM
Mapping ROM


ttya initialized
```

```
i
SPARCstation 564, No Keyboard
ROM Rev. 2.14.4, 64 MB memory installed, Serial #4096.
Ethernet address 0:80:b6:1:2:3, Host ID: 80001000.


Rebooting with command: net
Boot device: /iommu/sbus/ledma@4,8400010/le@4,8c00000  File and args:
Automatic network cable selection succeeded : Using TP Ethernet Interface
1d400
Automatic network cable selection succeeded : Using TP Ethernet Interface
Using IP Address 198.211.242.188 = C6D3F2BC
hostname: 564_1
domainname: noname
server name 'mp112'
root pathname '/export/root/564_1'
root on mp112:/export/root/564_1 fstype nfs
Boot: vmunix
Size: 1548288+464288+225760 bytes
VAC ENABLED
SunOS Release 4.1.4 (GENERIC) #1: Fri Jun 16 17:00:30 PDT 1995
Copyright (c) 1983-1993, Sun Microsystems, Inc.
cpu = THEMIS,564
mod0 = FMI,MB86904 (mid = 0)
mem = 65220K (0x3fb1000)
avail mem = 61083648
entering uniprocessor mode
Ethernet address = 0:80:b6:1:2:3
espdma0 at  SBus slot 4 0x8400000
esp0 at  SBus slot 4 0x8800000 pri 4 (onboard)
esp0: Warning- no devices found for this SCSI bus
SUNW,bpp0 at  SBus slot 4 0xc800000 pri 3 (sbus level 2)
ledma0 at  SBus slot 4 0x8400010
le0 at  SBus slot 4 0x8c00000 pri 6 (onboard)
Warning: Out of range register specification in device node <flash>
Warning: Out of range register specification in device node <flash>
Warning: Out of range register specification in device node <flash>
zs0 at  SBus slot 4 0x1100000 pri 12 (onboard)
zs1 at  SBus slot 4 0x1000000 pri 12 (onboard)
SUNW,fdtwo0 at  SBus slot 4 0x1400000 pri 11 (onboard)
```

```
SBVME: address 1080000 (vme32d32) not found in VME range table; ignoring
               isc.
SBVME: address 1080400 (vme32d32) not found in VME range table; ignoring
               isc.
SBVME: address 1080800 (vme32d32) not found in VME range table; ignoring
               isc.
SBVME: address 1080c00 (vme32d32) not found in VME range table; ignoring
               isc.
SBVME: address 1081000 (vme32d32) not found in VME range table; ignoring
               isc.
SBVME: address 1000000 (vme32d32) not found in VME range table; ignoring
               mcp.
SBVME: address 1010000 (vme32d32) not found in VME range table; ignoring
               mcp.
SBVME: address 1020000 (vme32d32) not found in VME range table; ignoring
               mcp.
SBVME: address 1030000 (vme32d32) not found in VME range table; ignoring
               mcp.
SBVME: address 2000000 (vme32d32) not found in VME range table; ignoring
               mcp.
SBVME: address 2010000 (vme32d32) not found in VME range table; ignoring
               mcp.
SBVME: address 2020000 (vme32d32) not found in VME range table; ignoring
               mcp.
SBVME: address 2030000 (vme32d32) not found in VME range table; ignoring
               mcp.
hostname: 564_1
domainname: noname
root on mp112:/export/root/564_1 fstype nfs
swap on mp112:/export/swap/564_1 fstype nfs size 16384K
dump on mp112:/export/swap/564_1 fstype nfs size 16372K
checking filesystems
Automatic reboot in progress...
Wed Nov 15 15:14:05 PST 1995
checking quotas: done.
starting rpc port mapper.
starting RPC key server.
network interface configuration:
le0: flags=63<UP,BROADCAST,NOTRAILERS,RUNNING>
         inet 198.211.242.188 netmask ffffff00 broadcast 198.211.242.0
```

```
    ether 0:80:b6:1:2:3
lo0: flags=49<UP,LOOPBACK,RUNNING> inet 127.0.0.1 netmask ff000000
rdate mp112
Wed Nov 15 15:14:15 1995
mount -vat nfs
mount: mp112:/export/exec/sun4.sunos.4.1.4 already mounted
mount: mp112:/export/exec/kvm/sun4m.sunos.4.1.4 already mounted
mp112:/export/share/sunos.4.1.4 mounted on /usr/share
mp112:/home/mp112 mounted on /home/mp112
mp112:/var/spool/mail mounted on /var/spool/mail
starting additional services: biod.
starting system logger
starting local daemons: auditd sendmail statd lockd.
link-editor directory cache
preserving editor files
clearing /tmp
standard daemons: update cron uucp.
starting network daemons: inetd printer.
Wed Nov 15 15:14:19 PST 1995

564_1 login:
564_1 login: root
Nov 15 15:14:50 564_1 login: ROOT LOGIN console
Last login: Wed Nov 15 14:44:49 on console
SunOS Release 4.1.4 (GENERIC) #1: Fri Jun 16 17:00:30 PDT 1995
564_1#
564_1#
564_1#
564_1#
564_1# df
Filesystem              kbytes    used   avail capacity  Mounted on
mp112:/export/root/564_1
                        189383   59730  110715    35%    /
mp112:/export/exec/sun4.sunos.4.1.4
                        710110  162944  476155    25%    /usr
mp112:/export/exec/kvm/sun4m.sunos.4.1.4
                        189383   59730  110715    35%    /usr/kvm
mp112:/export/share/sunos.4.1.4
                        710110  162944  476155    25%    /usr/share
mp112:/home/mp112       710110  162944  476155    25%    /home/mp112
mp112:/var/spool/mail
```

```
            189383    59730   110715     35%     /var/spool/mail
564_1#
```

10. Download the VME patch on the client, and install them.

11. Reboot the client. If it's a THEMIS 5-64, you need to run "add_vme" under OBP, to declare your A32 boards, that will be accessed by the 5_64.

-=-

TN102:VME configuration on SPARC 10MP

-=-

Object: Configure VME interface

Boards:SPARC 10MP

Operating system:SOLARIS 2.3, 2.4

1) Default values for VMEBus request level, size of A32 slave window, and base
address of A32 slave window can be overriden by OBP properties.

These properties are respectively named "bus-request-level", "a32-size" and "a32-base". They are replicates of the corresponding bit fields in the VME Master and Slave Configuration registers described at the end of this note.

Generally spekaing, the command syntax for setting an OBP property is :

<hex value to set> xdrint " <property-name>" attribute

Notice that the space character between the quote and the property name is mandatory.

Such settings can be made permanent in NVRAM for automatic execution, by use of
"nvedit". See manual "OpenBoot Command Reference" for a description of nvedit.

Example : Set Bus request level to 2, A32 slave address to 0x80000000, A32 slave
window size to 32 MB.

```
ok nvedit
1: cd /THEMIS,vme
2: 2 xdrint " bus-request-level" attribute
3: 80 xdrint " a32-base" attribute
```

```
4: 1 xdrint " a32-size" attribute
5: ^C
 ok nvstore
ok setenv use-nvramrc? true
ok reset
```

(<Caution> : the last command will reset the board !)

Changes may be examined by :

```
ok cd /THEMIS,vme
ok .attributes
```

Note that A32 slave access is normally left disabled. Use patch_kmem below to enable it.

2) Other default system values for configuration of VME interface can be overridden by patching MVIC registers from applications running in user space.

As a matter of fact, MVIC registers are accessible in /dev/kmem, starting at location 0xFFED.B000.
This address corresponds to the "address" property, as defined by OBP in the "/THEMIS,vme" device node.

A sample C file for patching /dev/kmem, "patch_kmem.c" is included in this note. It must be run in superuser mode :

```
patch_kmem ffedbff0
-> Read VMEbus master configuration register

patch_kmem ffedbfe8 2800000
-> Set VME A32 slave address to 0x8000.0000,
   VME A32 slave window size to 64 MB.
```

VMEbus Master Configuration Register (offset 0xFF0)
==========

bit [31]VME Slave A32 Address space enable

If set to 1, slave access in A32 address space is enabled.

bit [30]VME Slave A24 Address space enable
If set to 1, slave access in A24 address space is enabled.

bit [29]VME Slave A16 Address space enable
If set to 1, slave access in A16 address space is enabled. Always to be left disabled under Solaris.

bits [28:15]Reserved

bits [14:11] A24 Slave Base Address
These 4 bits determine where in the A24 slave address space the 1MB DVMA region will respond to. Note that DVMA (Direct Virtual Memory Access) is reserved for SunOS device drivers.

Bits [14:11] correspond to bits [23:20] of VME A24 address.

bits [10:8] Reserved

bits [7:6]VMEbus DTACK time-out
This field determines how long the MVIC waits for a slave to respond with a DTACK before asserting a Bus Error on the VMEbus.

bits [7:6]time-out
---
0 0 51.2 us
0 1 12.8 us
1 0 3.2 us
1 1 none

bits [5:4]VMEbus Bus Request time-out
This field determines how long the MVIC waits to acquire the VMEbus before asserting a Bus Error on the VMEbus or halting the DMA transfer.

bits [5:4]time-out
---

0 01638.4 us
0 1 409.6 us
1 0 12.8 us
1 1 none

bits [3:2]VMEBus Request Level

bits [3:2] Bus Request Level
---
0 0 0
0 1 1
1 0 2
1 1 3

bit [1]VMEbus Arbiter mode
When set to 1, the VMEbus will arbitrate the bus requests in a round-robin manner. Otherwise a fixed priority scheme will be used.

bit [0]Reserved

VMEbus Slave Configuration Register (offset 0xFE8)
==========

bits [31:28]Reserved

bits [27:24]A32 VME Slave Window Size

bits [27:24] A32 Slave Window Size
---
0 16 MB
1 32 MB
2128 MB
3 256 MB
4512 MB

The board will respond if the A32 enable bit is set and :
Window Start Address + Size > VME Addr >= Window Start Address

bits [23:16] A32 Slave Base Address
Determines the starting VMEbus address the board will respond to in A32 slave mode. These 8 bits correspond to bits [31:24] of VME A32 address.

bits [15:0]Reserved

(Note that all "Reserved" bits shall not be modified)

```
-------- Cut here for patch_kmem.c --------
/*
 * PW 11/93. User access to kmem
 */

#include <fcntl.h>
#include <errno.h>
#include <sys/file.h>
#include <sys/types.h>
#include <sys/mman.h>

#define DATATYPE unsigned int

void main(argc,argv)
int argc;
char *argv[];
{
   int kmem;
   caddr_t pageptr;
   DATATYPE *ptr, oldvalue;
   unsigned addr, value;


/* Check args */
        if (argc < 2) {
usage:
                 printf("%s <hex address> [<hex value>]\n",argv[0]);
                exit(0);
   }
        sscanf(argv[1],"%x",&addr);
```

```
    if (argc == 3)                          /* value to set */
            sscanf(argv[2],"%x",&value);

/*
 * open kmem
 */
    if ((kmem = open("/dev/kmem",O_RDWR)) < 0) {
                perror("open error");
                exit(errno);
    }

/*
 * map it, at a page boundary
 */
    if ((pageptr = mmap(0L, PAGESIZE, PROT_READ|PROT_WRITE,
                        MAP_SHARED, kmem, (off_t)(addr & PAGEMASK))) ==
(caddr_t)-1) {
                perror("mmap error");
                exit(errno);
    }
    ptr = (DATATYPE *)((unsigned int)pageptr + (addr & PAGEOFFSET));

/*
 * Operations on kmem
 */
    oldvalue = *ptr;
    if (argc == 3)                          /* value to set */
      printf("0x%x : 0x%x --> 0x%x\n",addr,oldvalue,*ptr=(DATATYPE)value);
    else
      printf("0x%x : 0x%x\n",addr,oldvalue);

/*
 * unmap kmem
 */
    if (munmap(pageptr, PAGESIZE) == -1) {
                perror("munmap error");
                exit(errno);
    }
}

------- Cut here -------
```

7.7 *Removing NEXUS Driver*

TECHNICAL NOTE No 131-00
SUBJECT: Removing NEXUS driver on the 10MP
BOARD: THEMIS 10MP
O.S.: Solaris 2.4
Hardware rev: all
DATE: Oct 2, 1995

Since release 1.7, THEMIS solaris 2.4vme NEXUS driver is released in the pkgadd format. Some problems may occur if you are trying to run "pkgadd -d /dev/rmt/0" (package installation) on a system to which the VME NEXUS driver was installed using the former tvme-install install script.

The workaround is to follow those instructions:

1. Boot single user.
2. "rem_drv tvme" - - ignore any error messages that might result, such as "device busy".
3. "rem_drv mvc" - - again, ignore any error messages.
4. Restore /etc/system from /etc/system.bak. /etc/system.bak was created by the tvme-install script. If other changes have been made to /etc/system since tvme-install was run, then the lines related to the tvme driver should be removed manually, since restory from /etc/system/bak will result in loss of those changes. The relevant lines are:

   moddir: /kernel /usr/kernel /themis
   forceload: drv/tvme

5. Restore /etc/driver_classes or /kernel/drv/classes from the backup file, which will name /etc/driver_classes.bak or /kernel/drv/classes.bak. Again, if those files have bveen modified since tvme-install was run, the lines related to the tvme driver should be removed manually. The relevant line is:

   "THEMIS,vme"vme

6. Restore /etc/devlink.tab from /etc/devlink.tab.bak. Once again, be sure the file hasn't been modified since tvme-install was run, or else remove the lines related to tvme manually. The relevant lines are:

```
type=ddi_pseudo;name=mvc;minor=amvc0
type=ddi_pseudo;name=vmemem;minor=a32d32      vme32d32
type=ddi_pseudo;name=vmemem;minor=a24d32      vme24d32
type=ddi_pseudo;name=vmemem;minor=a16d32      vme16d32
type=ddi_pseudo;name=vmemem;minor=a32d16      vme32d16
type=ddi_pseudo;name=vmemem;minor=a24d16      vme24d16
type=ddi_pseudo;name=vmemem;minor=a16d16      vme16d16
```

7. Reboot the system using the '-r' flag
8. Run the "pkgadd -d /dev/rmt/0" command to install the new package. Then reboot the system using the '-r' flag.
9. Run the "pkginfo -l" to make sure the package was installed correctly.

7.8 *Determining Speed of MBus Modules*

TECHNICAL NOTE No 132-00
SUBJECT: Determining Speed of Ross MBUS modules.
BOARD: THEMIS 10MP
O.S.: all
Hardware rev: all
DATE: Oct 5, 1995

The proper way of determining the Frequency of an MBUS CPU module is to use the module-info command under OBP. Unfortunately, in the 10MP, module-info is printing a wrong value of the CPU frequency. The value is displayed using 2 digits only. So the upper digits will not be displayed. Sya, you have a 100MHZ module. Then module-info will reutrn "00 Hnz".

There is no special registers on the Ross modules, that tell users what is the frequency of the module they are using. OBP is timing a software loop to determine it.

The only way to find the frequency is to check the label on the Ross module MBUS connector. The first number of the left is giving the value (66, 90, 100,...).

7.9 Memory Error Message

TECHNICAL NOTE No 134-00
SUBJECT: "le0: memory error" warning message.
BOARD: THEMIS 10MP
O.S.: Solaris 2.4
Hardware rev: all
DATE: August 1, 1995

Under Solaris 2.4, and when the 10MP is making intensive SBUS and VME activity, the message:

le0: memory error

will pop-up at random occasions. This is due to the Lance (Ethernet) driver that is unable to access memory because of the system activity.

This problem is solved by a Sun patch, that deals with the latency time the driver can wait before getting access to memory. See below for a readme of that patch.

To install that patch:

```
# cd 101979-06
# ./installpatch .
```

To check if this patch is already installed:

showrev -p

To get that patch, or in case of problems:

THEMIS Technical Support
3185,Laurelview Court Fremont,CA 94538 USA
(510)252-0870
(510)490-5529
support@themis.com

Patch-ID# 101979-06
Keywords: ethernet driver memory le0 le ethernet aui hang
Synopsis: SunOS 5.4: le driver fixes
Date: Aug/22/95

Solaris Release: 2.4

SunOS Release: 5.4

Unbundled Product:

Unbundled Release:

Topic: SunOS 5.4: le driver fixes

BugId's fixed with this patch: 1145294 1161058 1171562 1177296

Changes incorporated in this version: 1177296

Relevant Architectures: sparc

Patches accumulated and obsoleted by this patch: 102444-01

Patches which conflict with this patch:

Patches required with this patch:

Obsoleted by:

Files included with this patch:

/kernel/drv/le

Problem Description:

1177296 ethernet interface hangs on large transfers over AUI but not TP

This is a recrank of 101979-05. -05 rev was missing 1177296 fix.

(from 101979-05)

1177296ethernet interface hangs on large transfers over AUI but not TP

(from 101979-04)

1161058 Under many collisions, get erroneous le0: No carrier message

Under many collisions, get erroneous le0: No carrier message

(from 101979-03)

1171562 Getting "le0: Memory error!" when copying large file across network

SS10 with dual processors running 2.3 with OLDS 2.0.1 installed, gets le0: Memory error when copying large files over the network. A hard hang then occurs. This eliminates console error message that existed with 101979-02.

(from 101979-02)

1171562 Getting "le0: Memory error!" when copying large file across network

SS10 with dual processors running 2.3 with OLDS 2.0.1 installed, gets le0: Memory error when copying large files over the network. A hard hang then occurs.

(from 101979-01)

1145294 classic 4.1.3C freeze 5-10Mins on receipt of Giant Packet from ff:ff:ff:ff:ff:ff

Problem is seen on active networks where the network interface on Classic's, LX's, Sparcstations 5 and 20 (based on MACIO) may hang and ignore incoming ethernet packets after receipt of a giant packet that is greater than 4096 bytes. This fix will detect this condition and reset the ethernet interface to prevent the interface from hanging.

Patch Installation Instructions:

Generic 'installpatch' and 'backoutpatch' scripts are provided within each patch package with instructions appended to this section. Other specific or unique installation instructions may also be necessary and should be described below.

Special Install Instructions:

None.

Instructions to install patch using "installpatch"
---

1. Become super-user.
2. Apply the patch by typing:

   <dir>installpatch <patch-dir>

where <dir> is the directory containing installpatch, and <patch-dir> is the directory containing the patch itself.

Example:

```
# cd /tmp/123456-01
# ./installpatch.
```

3. If any errors are reported, see "Patch Installation Errors" in the Command Descriptions section below.

Instructions for installing a patch on a dataless client

1. Before applying the patch, the following command must be executed on the server to give the client read-only, root access to the exported /usr file system so that the client can execute the pkgadd command:

   share -F nfs -o ro,anon=0 /export/exec/<os_version>/usr

   The command:

   share -F nfs -o ro,root=<client_name> \
   /export/exec/<os_version>/usr

   accomplishes the same goal, but only gives root access to the client specified in the command.

2. Login to the client system and become super-user.
3. Continue with step 2 in the "Instructions to install patch using installpatch" section above.

Instructions for installing a patch on a diskless client

** To install a patch on a diskless client, you may either follow the instructions for installing on a dataless client (that is, you may logon to the client and install the patch), or you may use the following instructions to install the patch while on the server.

1. Find the complete patch for the root directory of the diskless client.
2. Install the patch normally, but add the command option -R<path> to the command line. <path> should be completely specified.

   Example:

   ```
   # cd /tmp/123456-01
   # ./installpatch -R /export/root/client1.
   ```

Instructions for backing out a patch using "backoutpatch"
---

1. Become super-user.
2. Change directory to /var/sadm/patch:

   cd /var/sadm/patch

3. Backout patch by typing:

   <patch-id>/backoutpatch <patch-id>

   where <patch-id> is the patch number.

   Example:

```
# cd /var/sadm/patch
# 123456-01/backoutpatch 123456-01
```

4. If any errors are reported, see "Patch Backout Errors" in the Command Description section below:

Instructions for backing out a patch on a dataless client
---

1. Give the client root access to /usr as specified in the installpatch section
2. Logon to the client and follow backoutpatch instructions as specified above.

Instructions for backing out a patch on a diskless client

** To backout a patch on a diskless client, you may either follow the instructions for backout on a dataless client (that is, you may logon to the client and backout the patch), or you may use the following instructions to backout the patch while on the server.

1. Find the complete path for the root directory of the diskless client.
2. Backout the patch normally, but add the command option -R <path> to the command line. <path> should be completely specified.

Example:

```
# cd /export/root/client1/var/sadm/patch
# ./123456-01/backoutpatch -R /export/root/client1 123456-01
```

Instructions for identifying patches installed on system:

Patch packets that have been installed can be identified by using the -p option. To find out which patches are installed on a diskless client, use both the -R <dir> option and the -p option, where <dir> is the fully specified path to the client's root directory.

```
#cd /tmp/123456-01
#./installpatch -p
#./installpatch -R /export/root/client1 -p
```

Also note that the command "showrev -p" will show the patches installed on the local machine, but will not show patches installed on clients.

Command Descriptions

NAME

installpatch - apply patch package to Solaris 2.x system
backoutpatch - remove patch package, restore previously saved files

SYNOPSIS

installpatch [-udpV] [-S <service>] <patch number>
backoutpatch [-fV] [-S <service>] <patch number>

DESCRIPTION

These installation and backout utilities apply only to Solaris 2.x associated patches. They do not apply to Solaris 1.x associated patches. These utilities are currently only provided with each patch package and are not included with the standard Solaris 2.x release software.

OPTIONS

installpatch:

-u	unconditional install, turns off file validation. Allows the patch to be applied evenr if some of the files to be patched have been modified since original installation.
-d	Don't back up the files to be patched. This measn that the patch CANNOT BE BACKED OUT.
-p	Print a list of the patches currently applied
-V	Print script version number
-S	<service> Specify an alternate serviec (e.g. Solaris_2.3) for patch package processing references.
-R	<dir> Specify an alternate package installation root. Most useful for installaing patches on diskless clients while logged on to the server.

backourpatch:

-f force the backout regardless of whether the patch was superseded

-V print version number only

-S <service> Specify an alternate service (e.g. Solaris_2.3) for patch package processing references.

-R <dir> Specify an alternate package installation root. Most useful for removing patches on diskless clients while logged on to the server.

DIAGNOSTICS

Patch Installation Errors:

Error message:

The prepatch script exited with return code <retcode>. Installpatch is terminating.

Explanation and recommended action: The prepatch script supplied with the patch exited with a return code other than 0. Run a script trace of the installpatch and find out why the prepatch had a bad return code. Fix the problem and re-run installpatch.

To execute a script trace:

```
# sh -x ./installpatch . > /tmp/patchout 2>&1
```

The file /tmp/patchout will list all commands executed by installpatch. You should be able to determine why your prepatch script failed by looking through the /tmp/patchout file. If you still can't determine the reason for failure, contact customer service.

Error message:

The postpatch script exited with return code <retcode>. Backing out patch.

Explanation and recommended action: The postpatch script provided with the patch exited with an error code other than 0, and the patch has not previously been applied. Installpatch will execute backoutpatch to return the system to its pre-patched state. Create a script trace of the installpatch (see above) and find out why the postpatch script failed. Correct and re-execute installpatch. If you are unable to determine why the postpatch script failed, contact customer service.

Error message:
The postpatch script exited with return code <retcode>.
Not backing out patch because this is a re-installation.
The system may be in an unstable state!
Installpatch is terminating.

Explanation and recommended action: The postpatch script provided with the patch exited with an error code other than 0. Because this is a re-installation of a patch, installpatch will not automatically backout the patch. You may backout the patch manually using the backoutpatch command, then generate a script trace of the installpatch as described above. Find out why the postpatch failed, correct the problem, and re-install the patch. If you are unable to determine why the postpatch script failed, contact customer service.

Error message:
Patch <patch-id> has already been applied.

Explanation and recommended action: This patch has already been applied to the system and no additional patch packages would be added due to a re-installation. If the patch has to be reapplied for some reason, backout the patch and then reapply it.

Error message:
Symbolic link in package <pkg>
Symbolic links can't be part of a patch.
Installpatch is terminating.

Explanation and recommended action: The patch was incorrectly built. Contact customer service to get a new patch.

Error message:
This patch is obsoleted by patch <patch-id> which has already been applied to this system. Patch installation is aborted.

Explanation and recommended action: Occasionally, a patch is replaced by a new patch which incorporates the bug fixes in the old patch and supplies additional fixes also. At this time, the earlier patch is no longer made available to users. The second patch is said to "obsolete" the first patch. However, it is possible that some users may still have the earlier patch and try to apply it to a system on which the later patch is already applied. If the obsoleted patch were allowed to be applied, the additional fixes supplied by the later patch would no longer be available, and the system would be left in an inconsistent state. This error message indicates that the user attempted to install an obsoleted patch. There is no need to apply this patch because the later patch has already supplied the fix.

Error Message:
None of the packages to patch are installed on this system.

Explanation and recommended action: The original packages for this patch have not been installed and therefore the patch cannot be applied. The original packages need to be installed before applying the patch.

Error message:
This patch is not applicable to client systems.

Explanation and recommended action: The patch is only applicable to servers and standalone machines. Attempting to apply this patch to a client system will have no effect on the system.

Error message:
The -S and -R arguments are mutually exclusive.

Explanation and recommended action: You have specified both a non-native service to patch, and a package installation root. These two arguments are mutually exclusive. If patching a non-native usr partition, the -S option should be used to patch all clients using that service. If patching a client's root partition (either native or non-native), the -R option should be used.

Error message:
The <service> service cannot be found on this system.

Explanation and recommended action: You have specified a non-native service to patch, but the specified service is not installed on your system. Correctly specify the service when applying the patch.

Error message:
The Package Install Root directory <dir> cannot be found on this system.

Explanation and recommended action: You have specified a directory that is either not mounted, or does not exist on your system. Specify the directory correctly when applying the patch.

Error message:
The /usr/sbin/pkgadd command is not executable.

Explanation and recommended action: The /usr/sbin/pkgadd command cannot be executed. The most likely cause of this is that installpatch is being run on a diskless or dataless client and the /usr file system was not exported with root access to the client. See the section above on "Instructions for installing a patch on a diskless or dataless client".

Error message:
<patch-id> packages are not proper patch packages.

Explanation and recommended action: The patch directory supplied as an argument to installpatch did not contain the expected package format. Verify that the argument supplied to installpatch is correct.

Error message:
The following validation error was found:
<validation error(s)>

Explanation and recommended action: Before applying the patch, the patch application script verifies that the current versions of the files to be patched have the expected fcs checksums and attributes. If a file to be patched has been modified by the user, the user is notified of this fact. The user then has the opportunity to save the file and make a similar change to the patched version. For example, if the user has modified /etc/inet/inetd.conf and /etc/inet/inetd.conf is to be replaced by the patch, the user can save the locally modified /etc/inet/inetd.conf file and make the same modification to the new file after the patch is applied. After the user has noted all validation errors and taken the appropriate action for each one, the user should re-run installpatch using the "-u" (for "unconditional") option. This time, the patch installation will ignore validation errors and install the patch anyway.

Error message:
Insufficient space in /var/sadm/patch to save old files.

Explanation and recommended action: There is insufficient space in the /var/sadm/patch directory to save old files. The user has two options for handling this problem: (1) generate additional disk space by deleting unneeded files, or (2) override the saving of the old files by using the "-d" (do not save) option when running installpatch. However if the user elects not to save the old versions of

the files to be patched, backoutpatch CANNOT be used.

One way to regain space on a system is to remove the save area for previously applied patches. Once the user has decided that it is unlikely that a patch will be backed out, the user can remove the files that were saved by installpatch. The following commands should be executed to remove the saved files for patch xxxxxx-yy:

```
cd /var/sadm/patch/xxxxxx-yy
rm -r save/*
rm .oldfilessaved
```

After these commands have been executed, patch xxxxxx-yy can no longer be backed out.

Error message:
Save of old files failed.

Explanation and recommended action: Before applying the patch, the patch installation script uses cpio to save the old versions of the files to be patched. This error message means that the cpio failed. The output of the cpio would have been preceded this message. The user should take the appropriate action to correct the cpio failure. A common reason for failure will be insufficient disk space to save the old versions of the files. The user has two options for handling insufficient disk space: (1) generate additional disk space by deleting unneeded files, or (2) override the saving of the old files by using the "-d" option when running installpatch. However if the user elects not to save the old versions of the files to be patched, the patch CANNOT be backed out.

Error message:
Pkgadd of <pkgname> package failed with error code <code>. See /tmp/log.<patch-id> for reason for failure.

Explanation and recommended action: The installation of one of patch packages failed. Installpatch will backout the patch

to leave the system in its pre-patched state. See the log file for the reason for failure. Correct the problem and re-apply the patch.

Error message:

Pkgadd of <pkgname> package failed with error code <code>.
Will not backout patch...patch re-installation.
Warning: The system may be in an unstable state!
See /tmp/log.<patch-id> for reason for failure.

Explanation and recommended action: The installation of one of the patch packages failed. Installpatch will NOT backout the patch. You may manually backout the patch using backoutpatch, then re-apply the entire patch. Look in the log file for the reason pkgadd failed. Correct the problem and re-apply the patch.

Patch Installation Messages:

Note: the messages listed below are not necessarily considered errors as indicated in the explanations given. These messages are, however, recorded in the patch installation log for diagnostic reference.

Message:

Package not patched:
PKG=SUNxxxx
Original package not installed

Explanation: One of the components of the patch would have patched a package that is not installed on your system. This is not necessarily an error. A Patch may fix a related bug for several packages. Example: suppose a patch fixes a bug in both the online-backup and fddi packages. If you had online-backup installed but didn't have fddi installed, you would get the message

Package not patched:
PKG=SUNWbf
Original package not installed

This message only indicates an error if you thought the package was installed on your system. If this is the case, take the necessary action to install the package, backout the patch (if it installed other packages) and re-install the patch.

Message:

Package not patched:
PKG=SUNxxx
ARCH=xxxxxxx
VERSION=xxxxxxx
Architecture mismatch

Explanation: One of the components of the patch would have patched a package for an architecture different from your system. This is not necessarily an error. Any patch to one of the architecture specific packages may contain one element for each of the possible architectures. For example, Assume you are running on a sun4m. If you were to install a patch to package SUNWcar, you would see the following (or similar) messages:

Package not patched:
PKG=SUNWcar
ARCH=sparc.sun4c
VERSION=11.5.0,REV=2.0.18
Architecture mismatch

Package not patched:
PKG=SUNWcar
ARCH=sparc.sun4d
VERSION=11.5.0,REV=2.0.18
Architecture mismatch

Package not patched:
PKG=SUNWcar
ARCH=sparc.sun4e
VERSION=11.5.0,REV=2.0.18
Architecture mismatch

Package not patched:
PKG=SUNWcar

ARCH=sparc.sun4
VERSION=11.5.0,REV=2.0.18
Architecture mismatch

The only time these messages indicate an error condition is if installpatch does not correctly recognize your architecture.

Message:
Package not patched:
PKG=SUNxxxx
ARCH=xxxx
VERSION=xxxxxxx
Version mismatch

Explanation: The version of software to which the patch is applied is not installed on your system. For example, if you were running Solaris 5.3, and you tried to install a patch against Solaris 5.2, you would see the following (or similar) message:

Package not patched:
PKG=SUNWcsu
ARCH=sparc
VERSION=10.0.2
Version mismatch

This message does not necessarily indicate an error. If the version mismatch was for a package you needed patched, either get the correct patch version or install the correct package version. Then backout the patch (if necessary) and re-apply.

Message:
Re-installing Patch.

Explanation: The patch has already been applied, but there is at least one package in the patch that could be added. For example, if you applied a patch that had both Openwindows and Answerbook components, but your system did not have Answerbook installed, the Answerbook parts of the patch would not have been applied. If, at a later time, you pkgadd Answerbook, you could re-apply the patch, and the Answerbook components of the

patch would be applied to the system.

Message:
Installpatch Interrupted.
Installpatch is terminating.

Explanation: Installpatch was interrupted during execution (usually through pressing ^C). Installpatch will clean up its working files and exit.

Message:
Installpatch Interrupted.
Backing out Patch...

Explanation: Installpatch was interrupted during execution (usually through pressing ^C). Installpatch will clean up its working files, backout the patch, and exit.

Patch Backout Errors:

Error message:
prebackout patch exited with return code <retcode>.
Backoutpatch exiting.

Explanation and corrective action: the prebackout script supplied with the patch exited with a return code other than 0. Generate a script trace of backoutpatch to determine why the prebackout script failed. Correct the reason for failure, and re-execute backoutpatch.

Error message:
postbackout patch exited with return code <retcode>.
Backoutpatch exiting."

Explanation and corrective action: the postbackout script supplied with the patch exited with a return code other than 0. Look at the postbackout script to determine why it failed. Correct the failure and, if necessary, RE-EXECUTE THE POSTBACKOUT SCRIPT ONLY.

Error message:
Only one service may be defined.

Explanation and corrective action: You have attempted to specify more than one service from which to backout a patch. Different services must have their patches backed out with different invocations of backoutpatch.

Error message:
The -S and -R arguments are mutually exclusive.

Explanation and recommended action: You have specified both a non-native service to backout, and a package installation root. These two arguments are mutually exclusive. If backing out a patch from a non-native usr partition, the -S option should be used. If backing out a patch from a client's root partition (either native or non-native), the -R option should be used.

Error message:
The <service> service cannot be found on this system.

Explanation and recommended action: You have specified a non-native service from which to backout a patch, but the specified service is not installed on your system. Correctly specify the service when backing out the patch.

Error message:
Only one rootdir may be defined.

Explanation and recommended action: You have specified more than one package install root using the -R option. The -R option may be used only once per invocation of backoutpatch.

Error message:
The <dir> directory cannot be found on this system.

Explanation and recommended action: You have specified a directory using the -R option which is either not mounted, or does not exist on your system. Verify the directory name and re-backout the patch.

Error message:
Patch <patch-id> has not been successfully applied to this system.

Explanation and recommended action: You have attempted to backout a patch that is not applied to this system. If you must restore previous versions of patched files, you may have to restore the original files from the initial installation CD.

Error message:
Patch <patch-id> has not been successfully applied to this system. Will remove directory <dir>

Explanation and recommended action: You have attempted to back out a patch that is not applied to this system. While the patch has not been applied, a residual /var/sadm/patch/<patch-id> (perhaps from an unsuccessful installpatch) directory still exists. The patch cannot be backed out. If you must restore old versions of the patched files, you may have to restore them from the initial installation CD.

Error message:
This patch was obsoleted by patch <patch number>. Patches must be backed out in the order in which they were installed. Patch backout aborted.

Explanation and recommended action: You are attempting to backout patches out of order. Patches should never be backed-out out of sequence. This could undermine the integrity of the more current patch.

Error message:
Patch <patch-id> was installed without backing up the original files. It cannot be backed out.

Explanation and recommended action: Either the -d option of installpatch was set when the patch was applied, or the save area of the patch was deleted to regain space. As a result, the original files are not saved and backoutpatch cannot be used. The original files can only be recovered from the original installation CD.

Error message:
pkgrm of <pkgname> package failed return code <code>.
See /var/sadm/patch/<patch-id>/log for reason for failure.

Explanation and recommended action: The removal of one of patch packages failed. See the log file for the reason for failure. Correct the problem and run the backout script again.

Error message:
Restore of old files failed.

Explanation and recommended action: The backout script uses the cpio command to restore the previous versions of the files that were patched. The output of the cpio command should have preceded this message. The user should take the appropriate action to correct the cpio failure.

KNOWN PROBLEMS:

On client server machines the patch package is NOT applied to existing clients or to the client root template space. Therefore, when appropriate, ALL CLIENT MACHINES WILL NEED THE PATCH APPLIED DIRECTLY USING THIS SAME INSTALLPATCH METHOD ON THE CLIENT. See instructions above for applying patches to a client.

A bug affecting a package utility (eg. pkgadd, pkgrm, pkgchk) could affect the reliability of installpatch or backoutpatch which uses package utilities to install and backout the patch package. It is recommended that any patch that fixes package utility problems be reviewed and, if necessary, applied before other patches are applied. Such existing patches are:

100901Solaris 2.1
101122Solaris 2.2
101331Solaris 2.3

SEE ALSO
pkgadd, pkgchk, pkgrm, pkginfo, showrev, cpio

7.10 VME Bus Interrupt Problem

TECHNICAL NOTE No 135-00
SUBJECT: VME Bus error and interrupt problem on 10MP/solaris2.4
BOARD: THEMIS 10MP
O.S.: Solaris 2.4
Hardware rev: all
DATE: October 1, 1995

There is problem in the way Solaris 2.4 is handling VME bus errors for HyperSparc MBUS modules. VME bus errors could result in a system crash, when made from a user program. The normal behavior is to send a signal to the task, not to crash the system.

Themis has released a new VME nexus driver(version 1.7) which is fixing that problem.

Also, the nexus driver was modified so as not to IACK VME interrupts which are masked on the 10MP. The problem was to be seen in the following situation:

There is an SBUS interrupt level 3. The 10MP needs to determine if the interrupt is a VME or SBUS interrupt. To do so, it is making an IACK cycle at level 3 on the VME. If the IACK cycle times-out, then the 10MP considers this was an SBUS interrupt. But suppose, that in the same time there was a local SBUS interrupt level 3 on the 10MP, there was also a VME interrupt level 3, from and to 2 other boards. Then, before version 1.7 of the VME nexus driver, the 10MP was going to IACK that interrupt. This was causing some kind of problems as the 10MP was IACKing an interrupt not meant to it. Also the 10MP would print a message, saying it got a Spurious interrupt.

The conclusion is that, it is wise to mask all VME interrupts not

used by the 10MP, as this will suppress the VME IACK cycle during SBUS interrupt. This will also increase interrupt latency for SBUS interrupts.

To check the version of the nexus driver:

pkginfo -l THEMISvme

To mask interruopts on the 10MP, please see TN107

7.11 10MP OBP PROM

TECHNICAL NOTE No 138-00
SUBJECT: New 10MP OBP prom (Watchdog reset/Solaris 112 boot problem)
BOARD: THEMIS 10MP
O.S.: Solaris 1.1.2 and 2.4
Hardware rev: all
DATE: October 18, 1995

The 10MP OBP prom 2.12.4 is solving 2 different problems on the 10MP:

1. Under Solaris 1.1.2: - Early ROSS modules (Freq<100MHZ) will not be able to boot solaris 1.1.2.
2. Under Solaris 2.4: - If users "break into" OBP, using the L1(STOP)-A keyboard keys, or the VT100 break key, then they won't to able to return to OBP by using the OBP "go" command. Instead they will get a "no program active" error message. Also, after the machine is halted, the message "Watchdog reset" will be printed.

7.12 New 10MP OBP PROM Reset

TECHNICAL NOTE No 139-00
SUBJECT: New 10MP OBP prom (Watchdog reset/Solaris 112 boot problem)
BOARD: THEMIS 10MP
O.S.: Solaris 1.1.2 and 2.4
Hardware rev: all
DATE: October 18, 1995

The 10MP OBP prom 2.12.4 is solving 2 different problems on the 10MP:

1. Under Solaris 1.1.2: - Early ROSS modules (Freq<100MHZ) will not be able to boot solaris 1.1.2.
2. Under Solaris 2.4: - If users "break into" OBP, using the L1(STOP)-A keyboard keys, or the VT100 break key, then they won't to able to return to OBP by using the OBP "go" command. Instead they will get a "no program active" error message. Also, after the machine is halted, the message "Watchdog reset" will be printed.

7.13 Using TTYC OBP PROM

TECHNICAL NOTE No 145-00
SUBJECT: Using the TTYC OBP prom
BOARD: THEMIS 10MP
O.S.: Solaris 2.x
Hardware rev: all
DATE: Nov, 1995

THEMIS provides a special OBP prom on the 10MP, for customers who wants to be able to use ttyc as a console.

After you set the ttyc and ttyd jumpers accordingly (from Keyboard/Mouse to TTYC and TTYD, see 10MP user's manual,

J2501 from 1-2 to 2-3
J2502 from 1-2 to 2-3)

you need to consider the following:

Solaris 2.X will boot under the new OBP without any OS modifications. The system will need to reconfigure devices, so after the new prom is installed, the system should be booted using 'boot -r'. However, Solaris wil not push the correct streams drivers onto ttyc by default. The result will be that the terminal modes will not echo correctly or perform canonical input and output processing until the system is in multi-user mode and at a login prompt. Once reaching a login prompt, login as root and edit the file /etc/iu.ap. Changes the lines referencing zs to the following:

```
zs    0      3      ldterm ttcompat
zs    131072 131075 ldterm ttcompat
```

This will cause the system to autopush the appropriate streams modules on ttyc and ttyd.

Sample Device Drivers 8

The software interface provided for the 10MP platform fully supports standard VMEbus device drivers written for Solaris environments. It is the intention of Themis Computer to fully support users who wish to write their own VME device drivers that would function on Themis SPARC 10MP platforms. To aid these users and to illustrate the specific features of the VMEbus architecture, Themis provides a number of sample device drivers. Themis provides the complete source code and the necessary configuration files for these drivers.

- vmeintr: is a sample driver provided by Themis Computer to illustrate the vectored interrupt mechanism of the VMEbus. The vmeintr driver relies on the driver configuration files to specify the interrupts it should handle. Each instance of the driver registers the interrupts with the system. Through the ioctls implemented by the driver, the user can generate interrupts and send them to the appropriate driver instances. The interrupt generator and the interrupt receiver need to run on different computers.

- vmedvma: is a sample driver provided by Themis Computer to illustrate the use of Direct Virtual Memory Access within a device driver. The user can ask the driver to allocate a DMA region on the VMEbus. The driver allocates all the necessary resources to support a DVMA transfer to this region. The driver also implements mechanisms by which the user program can writer to or read from the DVMA region

- simpledma: is a sample driver provided by Themis Computer to illustrate the use of Direct Memory Access within a device driver. It is a simplified version of the standard vmedma driver. This driver is mainly intended for programmers writing device drivers that perform DMA operations on the VMEbus.

The source and binary versions of these drivers can be found in the directory /opt/THEMISvme/drv. System programmers that are writing device drivers for VMEbus devices are strongly encouraged to go through the source code of these sample drivers. Along with the information found in Chapter 5, Writing Device Drivers, these sample drivers offer a good insight into the design and development of device drivers for VMEbus devices. The drivers can be modified without any restrictions.

The sample device drivers are not essential for the normal operation of the SPARC 10MP system. When the THEMISvme package is installed, the drivers and their configuration files are copied to the disk, but are not installed on the system. After rebooting the machine, the user may choose to install these drivers.

Scripts have been provided to perform the above tasks. The install.sample scripts copies the drivers (as they are packaged) to the /kernel/drv directory. It then installs the drivers on the system, creates the files under /dev and copies the header files into the /usr/include/themis directory. The remove.sample script undoes all the installation done by the install script. You are strongly urged to carefully review the scripts before executing them.

If you need to make any changes to the drivers, you need to compile the drivers after the changes. After that you can copy the newly built driver object files to the /kernel/drv directory. You can install the new drivers on the running system by first executing the rem_drv command and then the add_drv command.

The remove.sample script removes the sample drivers from the running system. The script deconfgures the drivers from the kernel and remove the driver object files from the /kernel/drv directory.

Manual Pages *A*

This section contains the manual pages for all the drivers provided by Themis Computer. Manual pages are available for the standard nexus and DMA drivers as well as the sample drivers. Online copies of the manual pages for the standard drivers can be found in the standard manual pages location. Online copies of manual pages for the sample drivers can be found in the /opt/THEMISvme/man directory.

NAME

"THEMIS,vme",tvme - Nexus driver for VME bus

SYNOPSIS

THEMIS,vme@f,f3fff000

DESCRIPTION

The tvme device driver is a VMEbus Nexus Driver designed especially for Themis Computer's SPARC10MP platforms. The driver is configured to be the bus nexus driver for the class "vme". All leaf drivers that specify their parent as "vme" will be attached to the tvme driver. The tvme driver provides support for all VMEbus operations, including VME interrupt processing, Direct Virtual Memory Access (DVMA) on the VMEbus, mapping of registers on the VMEbus to kernel space etc.

The tvme driver provides these features:

- Master access in VMEA24 mode

- Slave access in VMEA32 mode

- Direct Virtual Memory Access (DVMA) on the VMEbus

- Block Transfer in Master and Slave modes

The interface between the VMEbus and the MBus is provided by the Fujitsu MB86986 MBus to VMEbus Interface Controller (MVIC). The tvme driver supports a single instance of MVIC. The driver initialises the controller for operation and handles asynchronous faults from the controller. User access to features of the MVIC, including the Direct Memory Access engine is provided by the mvc(7) driver.

The tvme driver supports the vectored interrupt mechanism of the VMEbus architecture. All vme devices that generate interrupts are expected to provide the 'interrupts' property in the device configuration file. The tvme driver supports SPARC interrupt priorities 2,3,5,7,9,11 and 13. The driver handles interrupt vectors 0 to 255.

The driver fully supports Direct Virtual Memory Access on the VMEbus. All the DVMA requests from vme device drivers are completely handled by the driver. A DVMA request can be made for a maximum of 1024 Kilobytes at a time.

FILES

/kernel/drv/tvme

SEE ALSO

vme(4)

driver.conf(4)

Themis Computer SPARC10MP Technical Manual

Themis Computer SPARC10MP Software Manual

NAME

vmedma - Themis driver for Direct Memory Access

SYNOPSIS

```
fd = open ( "/dev/vmedma0", O_RDWR);

err = ioctl (fd, command, arg);
```

DESCRIPTION

On Themis Computer's SPARC10MP platforms, the Fujitsu MB86986 MBus to VMEbus Interface Controller (MVIC) features a a high performance DMA controller that provides bi-directional memory-to-VMEbus Direct Memory Access data transfers. The vmedma driver provides user programs access to the Direct Memory Access engine of the MVIC. The DMA engine can support all these transfers: - memory to VMEbus - VMEbus to memory - memory to memory

The vmedma driver is designed to provide a powerful mechanism for highly efficient transfers involving the memory and the VMEbus. The user interface is uniform across the different hardware platforms available from Themis Computer. The vmedma driver is configured as a child of the VMEbus nexus driver and will function only on Themis Computer platforms.

The driver supports the open(2), close(2), ioctl(2) and poll(2) system calls. The commands implemented by the driver are accessed through the ioctl(2) system call.The VIOCDMACOPY ioctl command implements the basic DMA transfer capability of the driver. In addition to transfers between VMEbus and memory, the vmedma driver also supports transfers from memory to memory and VMEbus to VMEbus. Depending on the capabilities of the hardware platform, these transfers may be emulated in software. The VIOCGETCAP ioctl command may be used to interrogate the capabilities of the underlying hardware mechanism.

The driver supports the poll(2) system call for the event POLLRDNORM. The poll(2) system call blocks till the hardware DMA engine is available and returns when the engine has completed all queued transfers. However, a successful return of poll(2) does not guarantee that a subsequent VIOCDMACOPY command issued by the thread will not block.

IOCTLS

VIOCDMACOPY This command performs a Direct Memory Access transfer between the specified address locations. The source address, destination address, size of the transfer and the type of

transfer are specified in a vme_dmacopy structure. A pointer to this structure is passed as the argument to the ioctl(2) call. The user program is suspended till the DMA transfer is complete, unless the VF_NOBLOCK flag is specified. The third argument of the ioctl(2) call is a pointer to a struct vme_dmacopy, which is defined in <themis/vmedmaio.h> as

```
struct vme_dmacopy {
     u_int dma_flags;    /* flags */
     void *dma_source;   /* source address */
     void *dma_dest;     /* destination address */
     void *dma_sourcehi;/* high bits in source address */
     void *dma_desthi;   /* high bits in dest. address */
     u_int dma_count;    /* byte count */
     struct vme_dmaresult *
     dma_result;         /* pointer to result area */
};

struct vme_dmaresult {
     int dmar_status;  /* status of request */
     void *dmar_bufid; /* retained buffer ID */
     int dmar_errno;   /* errno value */
};
```

dma_source and dma_dest specify the source and destination addresses, respectively, of the DMA transfer. If any or both of source and destination addresses are 64-bit VMEbus addresses, the dma_sourcehi and dma_desthi specify the corresponding higher bits of the addresses. The addresses are assumed to be user virtual addresses unless indicated otherwise by the dma_flags field.

The dma_flags member contains various flags, which are OR'ed together to form the request. The first several flags are used to control the direction and type of the DMA tranfer. The interpretation of the dma_source and dma_dest members is based on the value of dma_flags:

VF_SVME — The A32 VMEbus is the source of data for the transfer. If this flag is present, the dma_source value is an

A32 VMEbus address.

VF_SVME24 — The A24 VMEbus is the source of data for the transfer. If this flag is present, the dma_source value is an A24 VMEbus address.

VF_SVME64 — The A64 VMEbus is the source of data for the transfer. If this flag is present, the dma_source value is the low-order 32 bits of the A64 VMEbus address, and the dma_sourcehi value is the high-order 32 bits of the A64 VMEbus address.

VF_SVMED16 — The VMEbus source address refers to a D16 device.

VF_SVMED64 — The VMEbus source address refers to a D64 device.

VF_DVME — The VMEbus is the destination of data for the transfer. If this flag is present the dma_dest value is an A32 VMEbus address.

VF_DVME24 — The A24 VMEbus is the destination of data for the transfer. If this flag is present, the dma_dest value is an A24 VMEbus address.

VF_DVME64 — The A64 VMEbus is the destination of data for the transfer. If this flag is present, the dma_dest value is the low-order 32 bits of the

A64 VMEbus address, and the dma_desthi value is the high-order 32 bits of the A64 VMEbus address.

VF_DVMED16 The VMEbus destination address refers to a D16 device.

VF_DVMED64 The VMEbus destination address refers to a D64 device.

Additional flags are used to control the transfer as follows:

VF_BLT Use block transfer mode.

VF_NOWAIT If the DMA engine is busy, return an EBUSY error rather than queuing the request.

VF_NOBLOCK Return immediately after queuing or starting the request. The vme_dmaresult area will be updated when the tranfer completes. Additionally the user process can request to be notified via SIGIO that the transfer has completed. See below for more details.

VF_RETAINBUFFER
User memory buffer(s) are locked into memory. Any setup work that can be retained between uses of the buffer is retained. This may make repetitive transfers of small sizes more efficient. Specifying the flag results in valuable system resources being locked up. Hence this flag should be used

with care.

VF_SIGDONE — signal when done (non-blocking requests only)

VF_SIGALL — signal all state changes (nonblocking requests only)

In all cases, the address values must meet alignment restrictions. On SPARC10MP the addresses must be aligned on a 16-byte boundary. The dma_count member specifies the byte count of the transfer. It must be a multiple of sixteen bytes. The dma_result member points to a structure which is used to report information about the DMA transfer.

9

```
struct vme_dmaresult {
     int dmar_status;     /* status of request */
     void *dmar_bufid;    /* retained buffer ID */
     int dmar_errno;      /* errno value */
};
```

9

The dmar_status member contains a single value which represents the state of the transfer:

VS_WAITING — request is waiting for the DMA engine

VS_INPROG — request is in progress

VS_DONE — request has finished normally

VS_ERROR — request has terminated due to error

If a request terminates due to an error, the dmar_errno member will contain an appropriate errno value. If the VF_NOBLOCK flag is not used, this is the same as the errno returned from the ioctl(2) call.

If the VF_RETAINBUFFER flag is used, then dmar_bufid will contain a buffer handle which

should be used in future VIOCDMACOPY calls and then released by issuing a VIOCRELBUF ioctl(2) command. When using VF_RETAINBUFFER, the dma_result structure pointer is required. The dmar_bufid value of the structure should be initialized to 0 (null). In future requests using the same buffer or a subset thereof, the dmar_bufid value should contain the value placed there by the first call. When the buffer is no longer needed, VIOCRELBUF must be called with the returned dmar_bufid value to release the resources the retained buffer is using.

If the VF_NOBLOCK flag is used, then the result area is updated in real time. It is important the vme_dmaresult structure be allocated in static memory. Depending on the setting of the VF_SIGDONE and VF_SIGALL flags, SIGIO is sent to the process when the status changes (VF_SIGALL) or when the request is complete (VF_SIGDONE). When a request completes, SIGIO is sent to the process which made the request. The process must then inspect the result area(s) of its outstanding request(s) to determine that the request(s) did complete (with or without error). A SIGIO will be posted for every completed request (VF_SIGDONE) or status change (VF_SIGALL). However, signals are not queued, so the driver should inspect all outstanding result areas whenever a SIGIO is received.

VIOCRELBUF This ioctl is used release a buffer that was previously retained by specifying the VF_RETAINBUFFER flag for the VIOCDMACOPY command. The argument to the command is the dmar_bufid in the vme_dmaresult strcuture returned by a previous VIOCDMACOPY command. If the value passed in is not a valid buffer handle, EINVAL is returned. If there is a problem releasing the buffer, EFAULT is returned. A problem releasing the buffer indicates an internal driver error and should be reported Themis Technical Support.

VIOCGETCAP This ioctl is used to determine the capabilities of the underlying hardware. Note that

in most cases, if the hardware is incapable of performing a request via DMA then the work represented by the request will be performed via other mechanisms. This ensures a common interface for user programs across different hardware platforms available from Themis Computer. If the user programs wish to tailor the request to the hardware platform, they may do so by using the VIOCGETCAP command.

The third argument to the ioctl() call is a pointer to a vme_dmacap structure which is filled in upon return from the call.

```
struct vme_dmacap {
     u_int dmac_flags;    /* flags */
     u_int dmac_align;    /* alignment modulus */
     u_int dmac_min;      /* minimum effective size */
};
```

The dmac_flags member will contain zero or more of the following flags, OR'ed together:

VC_MEMTOMEM — Memory-to-memory transfers are done with a DMA engine. Otherwise, they are emulated with polled I/O.

VC_VMETOVME — VMEbus-to-VMEbus transfers are done with a DMA engine. Otherwise, they are emulated with polled I/O.

VC_VMETOMEM — VMEbus-to-memory transfers are done with a DMA engine. Otherwise, they are emulated with polled I/O.

VC_MEMTOVME — Memory-to-VMEbus transfers are done with a DMA engine. Otherwise, they are emulated with polled I/O.

VC_D16 — D16 transfers are DMA transfers. If this flag

is not present and a D16 transfer is requested, it will be done via polled I/O.

VC_A64 — VMEbus A64 accesses are supported. If this flag is not present and an A64 request is made, EINVAL will be returned.

VC_D64 — VMEbus D64 accesses are supported. If this flag is not present and a D64 request is made, EINVAL will be returned.

The dmac_align member contains the alignment modulus that must be used for the address and count when making requests. A misaligned request will provoke an EINVAL error return.

The dmac_min member contains a hint as to the minimum size of a DMA transfer. Transfers below the minimum size may be better accomplished via other system calls like read(2),write(2) etc.

Example code :

```
#include <stdio.h>
#include <sys/types.h>
#include <sys/stat.h>
#include <fcntl.h>
#include <unistd.h>
#include <signal.h>
#include <time.h>
#include <string.h>
#include <sys/errno.h>
#include <stdlib.h>

#include <themis/vmedmaio.h>

/*
```



```
* This is a sample program to illustrate the use of the vmedma driver
* The program transfers 1000 words to VME address 0x72a00000.
```

```
 * The program then reads the VME memory and verifies that the
 * data was copied correctly.
 */

/*
 * External data
 */
extern char *sys_errlist[];/* error strings */
extern int errno;


main(int argc, char * argv[])
{
struct vme_dmacopy dma;/* DMA request structure */
int i;/* loop counter */
struct vme_dmaresult *dmar = 0;/* result structure */
int fd;/* VME DMA engine fd */
struct timeval start, end;/* timing */
int ns;/* # of reqs started */
int err = 0;/* error flag */
double kb;/* kilobytes copied */
double secs;/* # of seconds */
long int * to_buf, * from_buf; /* memory buffers */


     /* open the DMA engine */
     if ((fd = open("/dev/vmedma0", O_RDWR)) < 0)
     {
     (void) fprintf(stderr,
"%s: can't open /dev/vmedma0: %s0,
            argv[0],  sys_errlist[errno]);
     exit(1);
     }

     /* allocate source memory buffer */
     if ((to_buf = (long int *)malloc ( 1024 * sizeof(long))) == NULL)
     {
     (void) fprintf(stderr,
     "%s: can't allocate source memory buffer: %s0,
         argv[0], sys_errlist[errno]);
     exit(1);
     }

     /* initialise the memory buffer with numbers from 0 to 1023 */
     for ( i = 0; i < 1024; i++)
     to_buf[i] = i;

     /* set up the DMA request
      *- memory to VMEbus
      *- 32-bit data, 32-bit address
```



```
      *- no BLT
      *- do not retain buffers
      */
```

```
                dma.dma_source = to_buf; /* DMA transfer is from memory to VMEbus
 */
                dma.dma_dest = (void *)0x72a00000;
                dma.dma_sourcehi = dma.dma_desthi = 0; /* no 64-bit addresses */
                dma.dma_count = 1024 * sizeof(long); /* length of data transfer *
/
                dma.dma_result = NULL; /* we don't bother about the result area *
/
                dma.dma_flags = VF_DVME; /* destination is VME; no other special
 stuff */

                if ( ioctl(fd, VIOCDMACOPY, &dma) < 0) {
                (void) fprintf(stderr,
                "%s: can't do DMA transfer: %s0,
                    argv[0], sys_errlist[errno]);
                free ( to_buf);
                exit(1);
                }

                free ( to_buf);

                /* allocate  destination memory buffer */

                if ((from_buf = (long int *)malloc ( 1024 * sizeof(long))) == NUL
L)
                {
                (void) fprintf(stderr,
                "%s: can't allocate destination memory buffer: %s0,
                    argv[0], sys_errlist[errno]);
                exit(1);
                }

                /* initialise the memory buffer with numbers from 0 to 1023 */
                for ( i = 0; i < 1024; i++)
                from_buf[i] = i;

                /* set up the DMA request
                 *- VMEbus to memory
                 *- 32-bit data, 32-bit address
                 *- no BLT
                 *- do not retain buffers
                 */
                dma.dma_source = (void *) 0x72a00000;
                dma.dma_dest = (void *) from_buf; /* DMA transfer is from VMEbus
 to memory */
                dma.dma_sourcehi = dma.dma_desthi = 0; /* no 64-bit addresses */
                dma.dma_count = 1024 * sizeof(long); /* length of data transfer *
/
                dma.dma_result = NULL; /* we don't bother about the result area *
/
                dma.dma_flags = VF_SVME; /* source is VME; no other special stuff
 */

                if (ioctl(fd, VIOCDMACOPY, &dma) < 0)
                {
```

```
            (void) fprintf(stderr,
            "%s: can't do DMA transfer: %s0,
                argv[0], sys_errlist[errno]);
            free ( from_buf);
            exit(1);
            }

            /* now compare what we read with what we wrote */
            for ( i = 0; i < 1024; i++)
            if ( from_buf[i] != i )
            printf(
        "Data check error at offset %x: got %x, expected %x0,
            i, from_buf[i], i);

            /* clean up and return */
            free ( from_buf);
            close ( fd);

        }
```

FILES

/dev/vmedma0

/usr/include/themis/vmectlio.h

/kernel/drv/vmedma.conf

SEE ALSO

tvme(7)

vme(4)

driver.conf(4)

Themis Computer SPARC10MP User Manual

Themis Computer SPARC10MP Software Manual

NAME

vmedvma - Themis sample driver for Direct Virtual Memory Access

SYNOPSIS

```
#include <themis/vmedvma.h>

fd = open ( "/dev/vmedvma0", O_RDWR);

err = ioctl( fd, cmd, arg);
```

DESCRIPTION

vmedvma is a sample driver provided by Themis Computer to illustrate the use of Direct Memory Access within a device driver. The driver is provided along with the source code to help developers writing vme device drivers. The driver will function only on Themis Computer platforms.

The user program invokes the driver by opening the device and issuing the appropriate ioctl() calls as needed. In addition to the open() and ioctl() system calls, the driver supports the close() system call to close the driver instance. Through the ioctl() commands provided, the user can allocate a number of DVMA regions on the VMEBus. The user can write to or read from these regions and free them.

IOCTL INTERFACE

The third argument to ioctl() is a pointer to a struct vme_dvmacopy, which is defined in <themis/vmedvma.h> as

```
struct vme_dvmacopy {
     int       size;
     int       id;
     caddr_t   addr;
     int       offset;
};
```

The size and offset parameters is specified by the application and is not modified by the driver. The addr parameter is used as a read/write parameter and can be changed by the application. The id member is used to identify the DVMA region and should not be modified by the application.

VDMA_ALLOCATE allocates a DMA region. The input parameter size specifies the size of the region to be allocated. The driver allocates a DVMA region and sets the id parameter. The address of the DVMA region is returned in the addr parameter. If a DMA region can not be allocated because of memory constraints, the ioctl() call fails and sets errno to ENOMEM. The id parameter is used to identify the allocated

DVMA region for all further operations on the region. Any other board on the VME chassis can access the allocted DVMA region using the addr parameter.

VDMA_FREE frees the DVMA region specified by the id parameter. All resources allocated for the region will be freed.

VDMA_WRITE copies data from user memory to the DVMA region. The id parameter must specify a value previously returned by a VDMA_ALLOCATE. The addr parameter specifies the user memory location from where the data will be copied. The size parameter specifies the amount of data to be copied. The offset parameter specifies the location from the beginning of the DVMA region where user data will be written to. The sum of size and offset must not be greater than the size of the allocated region.

VDMA_READ copies data from the DVMA region to user memory. The id parameter must specify a value previously returned by a VDMA_ALLOCATE. The addr parameter specifies the user memory location into which data will be copied. The size parameter specifies the amount of data to be copied. The offset parameter specifies the location from the beginning of the DVMA region from where the data will be read. The sum of size and offset must not be greater than the size of the allocated region.

Example code :

This program allocates a DVMA region that is 26 bytes long. It then writes the lower case alphabets into the region one character at a time. It then reads the data and compares them with what was written.

```
#include <stdio.h>
#include <sys/types.h>
#include <fcntl.h>

#include <themis/vmedvma.h>


main()
{
  int fd;
  int count;
  struct vme_dvmacopy dma_req;
  struct vme_dvmacopy dma_read;
  struct vme_dvmacopy dma_write;
  char alpha[26];
```

```
            char beta[26];

            /* open the device */
            if ((fd = open("/dev/vmedvma0", O_RDWR))<0)
            {
               perror("can't open /dev/vmedvma0");
               exit(1);
            }

            /* allocate a DVMA region */
            dma_req.size = 26;
            if (ioctl(fd, VDMA_ALLOCATE, &dma_req) != 0)
            {
               perror("In allocating DVMA");
               close(fd);
               return(-1);
            }

            printf("Allocated a DVMA region id : %d, at virtual sbus address : %
x0, dma_req.id, dma_req.addr);

            /* initialise the dma write request */
            dma_write.id = dma_req.id;
            dma_write.size = 1;


            /* write the alphabet  character by character */
            for ( count = 0; count < 26; count ++)
            {
               alpha[count] = 'a' + count;
               dma_write.addr = alpha+count;
               dma_write.offset = count;

               if (ioctl(fd, VDMA_WRITE, &dma_write) != 0)
               {
               perror("In writing ");
               close(fd);
               return(-1);
               }
            }

            /* initialise the dma read request */
            dma_read.id = dma_req.id;
            dma_read.size = 26;
            dma_read.addr = beta;
            dma_read.offset = 0;

            if (ioctl(fd, VDMA_READ, &dma_read) != 0)
            {
               perror("In reading ");
               close(fd);
               return(-1);
            }
```

```
        /* read the DVMA memory and compare with what was written */
        for ( count = 0; count < 26; count ++)
        {
           if ( alpha[count] != beta[count] )
           printf("Data mismatch: Wrote %c, Read %c0,
           alpha[count], beta[count]);

        }

        /* clean up and return */
        close(fd);
        return(0);

      }
```

FILES

/dev/vmedvma0

/usr/include/themis/vmedvma.h

/kernel/drv/vmedvma.conf

SEE ALSO

tvme(7)

vme(4)

driver.conf(4)

Themis Computer SPARC10MP Technical Manual

Themis Computer SPARC10MP Software Manual

NAME

vmeintr - Themis sample driver for VMEbus interrupts

SYNOPSIS

```
#include <themis/vmeintr.h>

fd = open ( /dev/vmeintr0 ,

err = ioctl( fd, SENDINTR, arg);
```

DESCRIPTION

vmeintr is a sample driver provided by Themis Computer to illustrate the vectored interrupt mechanism of the VMEbus. The driver is provided along with the source code to help developers writing vme device drivers. The driver will function only on Themis Computer platforms.

The driver provides a mechanism by which an interrupt can be generated on the VMEbus. This interrupt can be received by any other VME board on the VMEbus. The system that generates the interrupt would not receive it. The vmeintr driver relies on the driver configuration files to specify the interrupts it should handle. Each instance of the driver registers the interrupts with the system. Through the ioctls implemented by the driver, the user can generate interrupts and send them to the appropriate driver instances.

The user program invokes the driver by opening the device and issuing the appropriate ioctl() calls as needed. In addition to the open() and ioctl() system calls, the driver supports the close() system call to close the driver instance.

IOCTL INTERFACE

The third argument to ioctl() is a pointer to a struct vme_intr_vect, which is defined in <themis/vmeintr.h> as

```
typedef struct {
     int vector;
     int priority;
     long timeout;       /* used only for GETINTRDATA */
}vme_intr_vect ;
```

vector specifies the VMEbus interrupt vector and has a value between 0 - 255. priority specifies the VMEbus interrupt priority and has a value between 1 - 7. timeout is used only for the GETINTRDATA command and specifies the time in microseconds.

REQINTRSIGNAL prepares the driver to receive the specified interrupt from another board on the VME chassis. The

priority - vector pair should be a valid value specified in the configuration file. An invalid value will result in an error of EINVAL being returned.

SENDINTR sends the specified interrupt on the VMEbus. This interrupt will be received by any board on the VMEbus that has the particular interrupt enabled.

GETINTRDATA waits for the specified interrupt. If the interrupt has already been received, the call will return immediately. Otherwise the calling process will be blocked till the interrupt is received or till timeout microseconds ellapse, whichever occurs earlier. If the timeout is specified as -1, the calling process will be blocked till the interrupt is received.

Typically two systems sharing the same VME chassis are needed to use the vmeintr driver. One of the systems is used to generate the interrupts and another is used to receive the interrupts.

Example code (interrupt receiver):

```
#include <stdio.h>
#include <sys/types.h>
#include <fcntl.h>

#include <themis/vmeintr.h>

  .
  .
  .
  int fd;
  vme_intr_vect vect;
  vme_intr_vect vect_recvd;
  .
  .
  .

  if ((fd = open("/dev/vmeintr0", O_RDWR))<0)
  {
     perror("can't open /dev/vmeintr0");
     exit(1);
  }

  /* assume argv[1] specifies the vector and argv[2] specifies
      the priority
  */

  vect.vector = atoi ( argv[1] );
  vect.priority = atoi ( argv[2] );
```

```
        /* enable the interrupt */

        if (ioctl(fd, REQINTRSIGNAL, &vect) < 0)
        {
           perror("In enabling interrupts");
           close(fd);
           return(-1);
        }

        /* wait for the interrupt */
        printf("Waiting for interrupt : %d ...0, vect.vector);
        vect_recvd.timeout = 30 * 1000 * 1000; /* wait for 30 seconds */
        if (ioctl(fd, GETINTRDATA, &vect_recvd) < 0)
        {
           if(errno == ETIME)
           printf('Timeout occured. Interrupt was probably not generated.0);
           else
           perror("In receiving interrupts");
           close(fd);
           return(-1);
        }

        /* print the received interrupt */
        printf("Received vector %d at priority0, vect_recvd.vector,
           vect_recvd.priority);

        /* clean up and return */
        close(fd);
        return(0);
        .
        .
```

Example code (interrupt generator):

```
     #include <stdio.h>
     #include <sys/types.h>
     #include <fcntl.h>

     #include <themis/vmeintr.h>

       .
       .
       .
       int fd;
       vme_intr_vect vect;
       .
       .
       .

       if ((fd = open("/dev/vmeintr0", O_WRONLY))<0)
       {
```

```
        perror("can't open /dev/vmeintr0");
        exit(1);
    }

    /* assume argv[1] specifies the vector and argv[2] specifies
        the priority
    */

    vect.vector = atoi ( argv[1] );
    vect.priority = atoi ( argv[2] );


    /* send  the interrupt */
    printf("Sending interrupt : %d ...0, vect.vector);
    if (ioctl(fd, SENDINTR, &vect) < 0)
    {
        perror("In sending interrupts");
        close(fd);
        return(-1);
    }

    /* clean up and return */
    close(fd);
    return(0);
    .
    .
```

FILES

/dev/vmeintr0

/usr/include/themis/vmeintr.h

/kernel/drv/vmeintr.conf

SEE ALSO

tvme(7)

vme(4)

driver.conf(4)

Themis Computer SPARC10MP User Manual

Themis Computer SPARC10MP Software Manual

NAME

vmemem - Device driver for VMEbus access

SYNOPSIS

```
fd = open ( "/dev/vmeXXdYY", O_RDWR);
```

DESCRIPTION

The vmemem driver provides a standard way to access the VMEBus from user processes. The driver creates device special files under the /dev directory. These files support open(), close(), read(), write() and mmap() calls to access the VMEbus. The type of access to the VMEbus is indicated by the name of the device file:

/dev/vme32d32 - 32 bit address, 32 bit data /dev/vme32d16 - 32 bit address, 16 bit data /dev/vme24d32 - 24 bit address, 32 bit data /dev/vme24d16 - 24 bit address, 16 bit data /dev/vme16d32 - 16 bit address, 32 bit data /dev/vme16d16 - 16 bit address, 16 bit data

The user program accesses any part of the VMEbus address space by opening the device file and accessing it at a particular offset. For example, to access address location 0x72000000 of the 32 bit VME space, the user can open the file /dev/vme32d32 and seek to offset 0x72000000. For efficient access, the user can map the VMEbus address space into the user address space by using the mmap() system call.

This program accesses a specific region in the A32 address space. It initialises the region and reads the values back.

```
#include <stdio.h>
#include <sys/types.h>
#include <unistd.h>


main()
{
  int fd;
  int count;
  int value;

  /* open the device */
  if ((fd = open("/dev/vme32d32", O_RDWR))<0)
  {
```

```
        perror("can't open /dev/vmemem");
        exit(1);
    }

    lseek( fd, 0x72000000, SEEK_SET);

    value = 0;
    for ( count = 0; count < 1024; count ++)
        if ( write ( fd, &value, sizeof(int)) != sizeof(int) )
        perror("In writing");

    lseek( fd, 0x72000000, SEEK_SET);

    for ( count = 0; count < 1024; count ++)
    {
        if ( read ( fd, &value, sizeof(int)) != sizeof(int) )
        perror("In reading");
        else
        if ( value != 0)
        printf("Error at: %x, read %d instead of zero0,
        0x72000000 + (count * sizeof(int)), value);
    }

    close(fd);
    return(0);

}
```

FILES

/dev/vme32d32

/dev/vme32d16

/dev/vme24d32

/dev/vme24d16

/dev/vme16d32

/dev/vme16d16

/kernel/drv/vmemem.conf

SEE ALSO

tvme(7)

vme(4)

driver.conf(4)

Themis Computer SPARC10MP Technical Manual

Themis Computer SPARC10MP Software Manual

NAME

simpledma - Simplified sample driver for Direct Memory Access

SYNOPSIS

```
fd = open ( "/dev/simpledma0", O_RDWR);

err = ioctl (fd, command, arg);
```

DESCRIPTION

simpledma is a sample driver provided by Themis Computer to illustrate the use of Direct Memory Access from drivers for VMEbus devices. The driver is a simplified version of the more powerful vmedma driver. The driver is provided along with the source code. On Themis Computer's SPARCLXE+ and SPARC5/64 platforms, the Newbridge SCV64 VMEBus Controller (SCV64) features a a high performance DMA controller that provides bi-directional memory-to-VMEbus Direct Memory Access data transfers. The VMEbus nexus driver exports a set of functions that can be used by VME leaf drivers to do Direct Memory Access operations on the VMEbus. The simpledma driver illustrates the use of these functions. The simpledma driver is configured as a child of the VMEbus nexus driver and will function only on Themis Computer platforms.

The driver supports the open(2), close(2), ioctl(2) and poll(2) system calls. The commands implemented by the driver are accessed through the ioctl(2) system call.The VIOCDMACOPY ioctl command implements the basic DMA transfer capability of the driver. In addition to transfers between VMEbus and memory, the simpledma driver also supports transfers from memory to memory and VMEbus to VMEbus. Depending on the capabilities of the hardware platform, these transfers may be emulated in software. The VIOCGETCAP ioctl command may be used to interrogate the capabilities of the underlying hardware mechanism.

The driver supports the poll(2) system call for the event POLLRDNORM. The poll(2) system call blocks till the hardware DMA engine is available and returns when the engine has completed all queued transfers. However, a successful return of poll(2) does not guarantee that a subsequent VIOCDMACOPY command issued by the thread will not block.

IOCTLS

VIOCDMACOPY This command performs a Direct Memory Access transfer between the specified address locations. The source address, destination address, size of the transfer and the type of

transfer are specified in a vme_dmacopy structure. A pointer to this structure is passed as the argument to the ioctl(2) call. The user program is suspended till the DMA transfer is complete, unless the VF_NOBLOCK flag is specified. The third argument of the ioctl(2) call is a pointer to a struct vme_dmacopy, which is defined in <themis/vmedmaio.h> as

```
struct vme_dmacopy {
     u_int dma_flags;    /* flags */
     void *dma_source;   /* source address */
     void *dma_dest;     /* destination address */
     void *dma_sourcehi;/* high bits in source address */
     void *dma_desthi;   /* high bits in dest. address */
     u_int dma_count;    /* byte count */
     struct vme_dmaresult *
     dma_result;         /* pointer to result area */
};

struct vme_dmaresult {
     int dmar_status;  /* status of request */
     void *dmar_bufid; /* retained buffer ID */
     int dmar_errno;   /* errno value */
};
```

dma_source and dma_dest specify the source and destination addresses, respectively, of the DMA transfer. If any or both of source and destination addresses are 64-bit VMEbus addresses, the dma_sourcehi and dma_desthi specify the corresponding higher bits of the addresses. The addresses are assumed to be user virtual addresses unless indicated otherwise by the dma_flags field.

The dma_flags member contains various flags, which are OR'ed together to form the request. The first several flags are used to control the direction and type of the DMA tranfer. The interpretation of the dma_source and dma_dest members is based on the value of dma_flags:

VF_SVME — The A32 VMEbus is the source of data for the transfer. If this flag is present, the dma_source value is an

A32 VMEbus address.

VF_SVME24 — The A24 VMEbus is the source of data for the transfer. If this flag is present, the dma_source value is an A24 VMEbus address.

VF_SVME64 — The A64 VMEbus is the source of data for the transfer. If this flag is present, the dma_source value is the low-order 32 bits of the A64 VMEbus address, and the dma_sourcehi value is the high-order 32 bits of the A64 VMEbus address.

VF_SVMED16 — The VMEbus source address refers to a D16 device.

VF_SVMED64 — The VMEbus source address refers to a D64 device.

VF_DVME — The VMEbus is the destination of data for the transfer. If this flag is present the dma_dest value is an A32 VMEbus address.

VF_DVME24 — The A24 VMEbus is the destination of data for the transfer. If this flag is present, the dma_dest value is an A24 VMEbus address.

VF_DVME64 — The A64 VMEbus is the destination of data for the transfer. If this flag is present, the dma_dest value is the low-order 32 bits of the

A64 VMEbus address, and the dma_desthi value is the high-order 32 bits of the A64 VMEbus address.

VF_DVMED16 The VMEbus destination address refers to a D16 device.

VF_DVMED64 The VMEbus destination address refers to a D64 device.

Additional flags are used to control the transfer as follows:

VF_BLT Use block transfer mode.

VF_NOWAIT If the DMA engine is busy, return an EBUSY error rather than queuing the request.

VF_NOBLOCK Return immediately after queuing or starting the request. The vme_dmaresult area will be updated when the tranfer completes. Additionally the user process can request to be notified via SIGIO that the transfer has completed. See below for more details.

VF_SIGDONE signal when done (nonblocking requests only)

VF_SIGALL signal all state changes (nonblocking requests only)

In all cases, the address values must meet alignment restrictions. On SPARC5/64 the addresses must be aligned on a 8-byte boundary. The dma_count member specifies the

byte count of the transfer. It must be a multiple of eight bytes. The dma_result member points to a structure which is used to report information about the DMA transfer.

```
struct vme_dmaresult {
     int dmar_status;     /* status of request */
     void *dmar_bufid;    /* retained buffer ID */
     int dmar_errno;      /* errno value */
};
```

The dmar_status member contains a single value which represents the state of the transfer:

VS_WAITING	request is waiting for the DMA engine
VS_INPROG	request is in progress
VS_DONE	request has finished normally
VS_ERROR	request has terminated due to error

If a request terminates due to an error, the dmar_errno member will contain an appropriate errno value. If the VF_NOBLOCK flag is not used, this is the same as the errno returned from the ioctl(2) call.

If the VF_NOBLOCK flag is used, then the result area is updated in real time. It is important the vme_dmaresult structure be allocated in static memory. Depending on the setting of the VF_SIGDONE and VF_SIGALL flags, SIGIO is sent to the process when the status changes (VF_SIGALL) or when the request is complete (VF_SIGDONE). When a request completes, SIGIO is sent to the process which made the request. The process must then inspect the result area(s) of its outstanding request(s) to determine that the request(s) did complete (with or without error). A SIGIO will be posted for every completed request (VF_SIGDONE) or status change (VF_SIGALL). However, signals are not queued, so the driver should inspect all outstanding result areas whenever a SIGIO is

received.

VIOCGETCAP This ioctl is used to determine the capabilities of the underlying hardware. Note that in most cases, if the hardware is incapable of performing a request via DMA (such as memory-to-memory DMA transfer on SPARC5/64) then the work represented by the request will be performed via other mechanisms.. This ensures a common interface for user programs across different hardware platforms available from Themis Computer. If the user programs wish to tailor the request to the hardware platform, they may do so by using the VIOCGETCAP command.

The third argument to the ioctl() call is a pointer to a vme_dmacap structure which is filled in upon return from the call.

9

```
struct vme_dmacap {
     u_int dmac_flags;    /* flags */
     u_int dmac_align;    /* alignment modulus */
     u_int dmac_min;      /* minimum effective size */
};
```

9

The dmac_flags member will contain zero or more of the following flags, OR'ed together:

VC_MEMTOMEM Memory-to-memory transfers are done with a DMA engine. Otherwise, they are emulated with polled I/O.

VC_VMETOVME VMEbus-to-VMEbus transfers are done with a DMA engine. Otherwise, they are emulated with polled I/O.

VC_VMETOMEM VMEbus-to-memory transfers are done with a DMA engine. Otherwise, they are emulated with polled I/O.

VC_MEMTOVME Memory-to-VMEbus

transfers are done with a DMA engine. Otherwise, they are emulated with polled I/O.

VC_D16 — D16 transfers are DMA transfers. If this flag is not present and a D16 transfer is requested, it will be done via polled I/O.

VC_A64 — VMEbus A64 accesses are supported. If this flag is not present and an A64 request is made, EINVAL will be returned.

VC_D64 — VMEbus D64 accesses are supported. If this flag is not present and a D64 request is made, EINVAL will be returned.

The dmac_align member contains the alignment modulus that must be used for the address and count when making requests. A misaligned request will provoke an EINVAL error return.

The dmac_min member contains a hint as to the minimum size of a DMA transfer. Transfers below the minimum size may be better accomplished via other system calls like read(2),write(2) etc.

Example code :

```
#include <stdio.h>
#include <sys/types.h>
#include <sys/stat.h>
#include <fcntl.h>
#include <unistd.h>
#include <signal.h>
#include <time.h>
```



```
#include <string.h>
#include <sys/errno.h>
```

```
#include <stdlib.h>

#include <themis/vmedmaio.h>

/*
 * This is a sample program to illustrate the use of the simpledma dri
ver.
 * The program transfers 1000 words to VME address 0x72a00000.
 * The program then reads the VME memory and verifies that the
 * data was copied correctly.
 */

/*
 * External data
 */
extern char *sys_errlist[];/* error strings */
extern int errno;


main(int argc, char * argv[])
{
struct vme_dmacopy dma;/* DMA request structure */
int i;/* loop counter */
struct vme_dmaresult *dmar = 0;/* result structure */
int fd;/* VME DMA engine fd */
struct timeval start, end;/* timing */
int ns;/* # of reqs started */
int err = 0;/* error flag */
double kb;/* kilobytes copied */
double secs;/* # of seconds */
long int * to_buf, * from_buf; /* memory buffers */


     /* open the DMA engine */
     if ((fd = open("/dev/simpledma0", O_RDWR)) < 0)
     {
     (void) fprintf(stderr,
"%s: can't open /dev/simpledma0: %s0,
             argv[0],  sys_errlist[errno]);
     exit(1);
     }

     /* allocate source memory buffer */
     if ((to_buf = (long int *)malloc ( 1024 * sizeof(long))) == NULL)
     {
     (void) fprintf(stderr,
     "%s: can't allocate source memory buffer: %s0,
         argv[0], sys_errlist[errno]);
     exit(1);
     }
```



```
     /* initialise the memory buffer with numbers from 0 to 1023 */
     for ( i = 0; i < 1024; i++)
```

```
                to_buf[i] = i;

                /* set up the DMA request
                 *- memory to VMEbus
                 *- 32-bit data, 32-bit address
                 *- no BLT
                 *- do not retain buffers
                 */

                dma.dma_source = to_buf; /* DMA transfer is from memory to VMEbus
 */
                dma.dma_dest = (void *)0x72a00000;
                dma.dma_sourcehi = dma.dma_desthi = 0; /* no 64-bit addresses */
                dma.dma_count = 1024 * sizeof(long); /* length of data transfer *
/
                dma.dma_result = NULL; /* we don't bother about the result area *
/

                dma.dma_flags = VF_DVME; /* destination is VME; no other special
stuff */

                if ( ioctl(fd, VIOCDMACOPY, &dma) < 0) {
                (void) fprintf(stderr,
                "%s: can't do DMA transfer: %s0,
                    argv[0], sys_errlist[errno]);
                free ( to_buf);
                exit(1);
                }

                free ( to_buf);

                /* allocate  destination memory buffer */

                if ((from_buf = (long int *)malloc ( 1024 * sizeof(long))) == NUL
L)
                {
                (void) fprintf(stderr,
                "%s: can't allocate destination memory buffer: %s0,
                    argv[0], sys_errlist[errno]);
                exit(1);
                }

                /* initialise the memory buffer with numbers from 0 to 1023 */
                for ( i = 0; i < 1024; i++)
                from_buf[i] = i;

                /* set up the DMA request
                 *- VMEbus to memory
                 *- 32-bit data, 32-bit address
                 *- no BLT
                 *- do not retain buffers
                 */
                dma.dma_source = (void *) 0x72a00000;
                dma.dma_dest = (void *) from_buf; /* DMA transfer is from VMEbus
to memory */
                dma.dma_sourcehi = dma.dma_desthi = 0; /* no 64-bit addresses */
```

```
                dma.dma_count = 1024 * sizeof(long); /* length of data transfer *
/
                dma.dma_result = NULL; /* we don't bother about the result area *
/

                dma.dma_flags = VF_SVME; /* source is VME; no other special stuff
 */

                if (ioctl(fd, VIOCDMACOPY, &dma) < 0)
                {
                (void) fprintf(stderr,
                "%s: can't do DMA transfer: %s0,
                    argv[0], sys_errlist[errno]);
                free ( from_buf);
                exit(1);
                }


                /* now compare what we read with what we wrote */
                for ( i = 0; i < 1024; i++)
                if ( from_buf[i] != i )
                printf(
          "Data check error at offset %x: got %x, expected %x0,
                i, from_buf[i], i);

                /* clean up and return */
                free ( from_buf);
                close ( fd);

          }
```

FILES

/dev/simpledma0

/usr/include/themis/vmectlio.h

/kernel/drv/simpledma.conf

SEE ALSO

tvme(7)

vme(4)

driver.conf(4)

Themis Computer SPARC10MP Technical Manual

Themis Computer SPARC10MP Software Manual